Chapter 6
Avian Community

TABLE OF CONTENTS

FIGURES

TABLES

6.0 AVIAN COMMUNITY

The avian community at Batiquitos Lagoon had been monitored both informally and formally for many years prior to the lagoon restoration. Formal avian surveys were completed in 1987 and 1989 as part of early planning efforts for the restoration (Michael Brandman Associates, Inc. 1988, MEC Analytical Systems, Inc. 1990). In addition, the Audubon Society completed monthly surveys throughout the 1990's (Audubon Society, unpublished data), and Ms. Mona Baumgartel conducted the Batiquitos Lagoon Foundation Monthly Bird Survey from 1993 to 2003. Formal pre-restoration avian surveys were completed in 1994 and 1995 prior to initiation of dredging activity (Wetland Research Associates, Inc. 1995).

The primary goal of the present post-restoration avian monitoring program reported in this document was to track changes in abundance and diversity of avifauna at the lagoon following restoration. Post-restoration surveys were completed utilizing the methods of the 1994 and 1995 pre-restoration surveys. Additional focused monitoring for sensitive avian species including California least tern (*Sterna antillarum browni*), western snowy plover (*Charadrius alexandrinus nivosus*), and Belding's Savannah sparrow (*Passerculus sandwichensis beldingi*) was also completed and is discussed in a separate chapter.

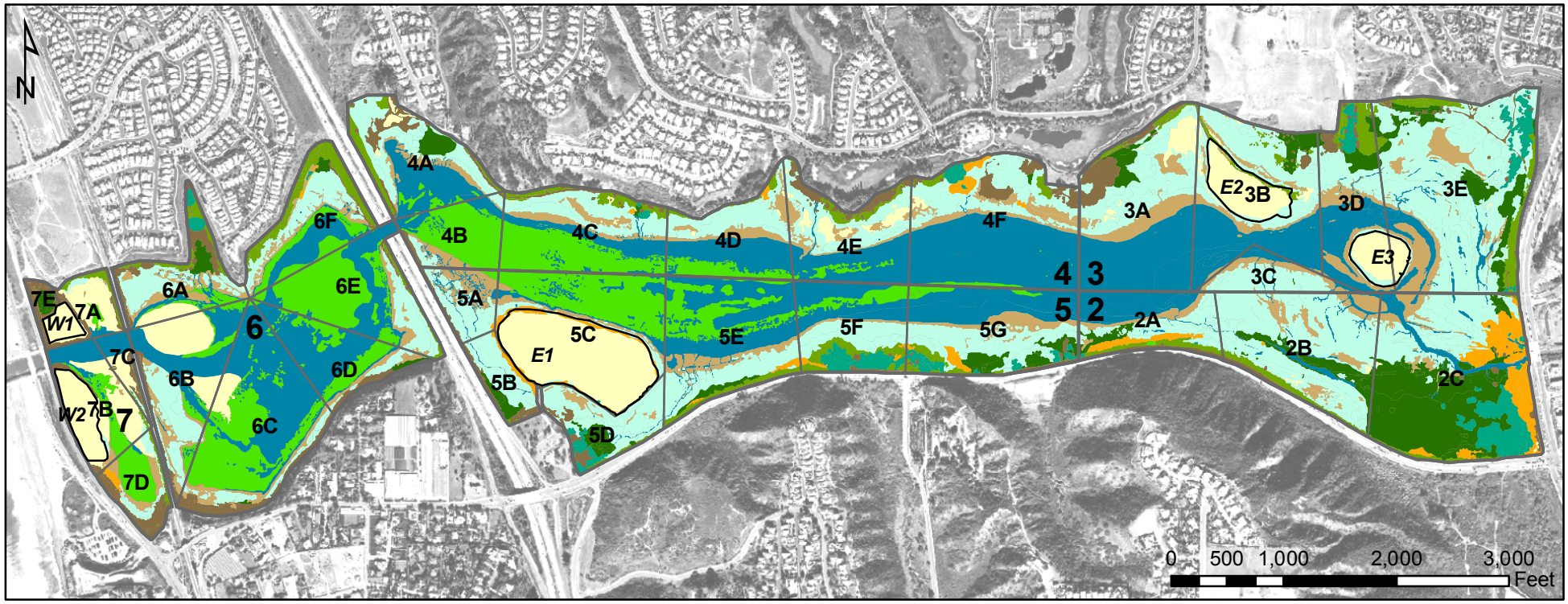
6.1 METHODS

6.1.1 Field surveys

Six study zones were established for the general avian surveys (Figure 6-1). These same areas were previously studied during the pre-restoration monitoring. Zone 1, located along Encinitas Creek south of La Costa Avenue, was not included in the current monitoring program, though it was surveyed in some pre-restoration survey work. Zone 2 was located in the southeast quadrant of the east basin of the lagoon. Zone 3 was located in the northeast quadrant of the east basin. Zone 4 was located in the northwest quadrant of the east basin, and Zone 5 was located in the southwest quadrant of the east basin. The center point of these four areas was located using dGPS and permanently marked with a PVC stake. Zone 6 consisted of the entire central basin of the lagoon, and Zone 7 represented the entire west basin of the lagoon. Each zone was subdivided into three to seven subzones (31 total) so that the data collected could be used to generate density maps for small regions within the lagoon.

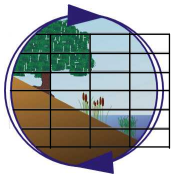
The lagoon was surveyed on foot by six to seven field biologists (divided into three teams) using binoculars and spotting scopes. Each team was responsible for surveying a portion of the lagoon. One team surveyed Zones 3 and 4, another team surveyed Zones 2 and 5, and the third team surveyed Zones 6 and 7. Zones 6 and 7 were surveyed by a single biologist from a kayak. All three teams conducted surveys simultaneously to count all birds present within the study zone. The entire lagoon was surveyed twice, on two consecutive days. Teams traveled from east to west during the first survey and from west to east during the second survey in order to observe each area during high and low tide. Data collected included species and individual counts, activity (foraging, flying, resting, or courting), and habitat occupied (defined as open water [>1 foot depth], shallow water [<1 foot depth], mud flat, sand beach, eelgrass bed, salt marsh, brackish marsh, freshwater marsh, willow/riparian, sage scrub, and upland non-wetlands).

This Page Intentionally Left Blank



Brackish Marsh
Cattail/Tule Marsh
Eelgrass Bed
Mudflat
Open Water
Sage Scrub
Salt Marsh
Sand Beaches/Bar
Shallow Water
Uplands
Willow/Riparian

2 Avian Survey Zone
2C Avian Survey Sub-zone
E3 Least Tern/Snowy Plover Nesting Site



Avian zone and subzone boundary map

Figure 6-1

Merkel & Associates, Inc.

This Page Intentionally Left Blank

Additional data collected included other factors affecting the behavior of birds, such as an injury or the presence of a predator. Weather conditions, including air temperature, wind speed, wind direction, cloud cover, precipitation, and tide height were recorded once each hour through the course of the surveys. After each survey, the teams compared data collected for each of the six study zones in order to correct any double counts of birds and to ensure consistency of data recording methods. In some cases, it was not possible to definitively assess whether a double-count had occurred, particularly with large flocks of highly transitory shorebirds and raptors, which range over all survey zones throughout the survey period. In cases where an over-count is suspected, a note has been made on the reported table of birds observed.

Surveys were conducted quarterly in January, April, July, and October in years 1, 2, 3, 5, and 10 (1997, 1998, 1999, 2001, and 2006) following the completion of restoration. The October 2006 survey had to be aborted and postponed to November 2006 when the lagoon did not drain to a suitable low tide to conduct the survey, although the survey had been scheduled based on predicted ocean tides and understood lag. The accumulated shoals in the central and west basins had reduced the numbers of days each month when the tide is appropriately low in the morning to conduct the survey. The survey results reflect the delay, with higher avian numbers than might have been expected in October, since the survey was conducted several weeks further in the fall migratory season. A table of survey dates is included in Appendix A6-1.

All survey data were initially recorded in the field on hard copy data sheets and then transferred in the office to digital database files and checked for accuracy. The database was then queried to extract summary information used to prepare tables and figures. Data were analyzed to identify spatial and temporal trends in total avian abundance, numbers of species, and patterns of habitat usage, activity, and seasonal variation.

6.1.2 Pre-Restoration Data Review

The pre-restoration data set collected by Wetlands Research Associates, Inc. (WRA) (1995), which was collected using the same methodology as the present surveys, was reviewed and incorporated into the analyses in order to make pre- and post-restoration comparisons. The only significant difference between the WRA surveys and the present surveys is the timing. While the present surveys adhered to a fixed quarterly interval (January, April, July and October of each year), the WRA surveys were conducted in August, December, April, and July.

Additional avian data were collected in 1987 and 1988 by Michael Brandman Associates, Inc. (MBA) using a similar methodology, zonation, and habitat descriptions, and again in 1989 by MEC Analytical Systems, Inc. (MEC) (1990). However, these two studies included an additional survey area within the willows and Baccharis scrub along Encinitas Creek, just south of La Costa Avenue. They were also done over the course of a single full day, with a single team. This differs from the present and WRA survey work, which was conducted in morning hours, with a larger team simultaneously, repeated two days in a row.

Data collected by the Audubon Society and the Batiquitos Lagoon Foundation were reviewed but reported on in this document only to a limited degree due to considerable differences in survey methodology.

All pre-restoration data from 1987, 1988, 1989, 1994, and 1995 presented in the results below are from MBA, MEC, and WRA. The variations in methodology could result in method-related variations in abundance and diversity; however, the surveys provide useful pre-restoration data for comparison to post-restoration conditions. Although these pre-restoration data are included in the chart in the following section, the focus of the results being presented is on the post-restoration conditions documented by the present study. When making comparisons to the pre-restoration data provided, it should be noted that the pre-restoration surveys were not conducted during consistent months each year and that water levels and available mudflat within the lagoon were highly variable between surveys. Prior to restoration, extreme fluctuations in water quality and lack of regular flushing often led to seasonal blooms of algae, reduced dissolved oxygen, and a low diversity of aquatic species, which could result in similar fluctuations in avian usage. When making comparisons between individual surveys (both pre- and post-restoration), it should also be noted that single point-in-time surveys each season do not account for inter-annual variations in seasonal cycles of migration and activity or inter-lagoon movements of birds within a given season.

6.2 RESULTS

Over the course of 40 post-restoration surveys conducted from 1997 to 2006, a total of 168 species of birds were observed at Batiquitos Lagoon following the opening of the lagoon to the ocean. A table of all bird counts by species by quarter is included in Appendix A6-2. Table 6-1 summarizes the results of the surveys.

Table 6-1. Summary of post-restoration avian abundance at Batiquitos Lagoon from 1997-2006.

Survey Quarter	Total Families	Total Species	Mean Individuals per Survey*
January 1997	26	84	6,882
April 1997	26	85	4,648
July 1997	23	79	2,565
October 1997	25	89	5,591
January 1998	27	94	7,617
April 1998	27	92	2,505
July 1998	26	71	2,168
October 1998	27	86	3,710
January 1999	23	88	4,115
April 1999	26	95	3,406
July 1999	24	79	2,574
October 1999	28	80	4,089
January 2001	23	87	2,460
April 2001	25	83	2,297
July 2001	25	70	1,511
October 2001	27	91	2,438
January 2006	28	86	7,953
April 2006	31	99	4,108
July 2006	30	81	1,151
November 2006	28	89	4,619

* Mean of bird counts on two consecutive days each quarter

In the following results and discussion, all references to individual bird counts during a given survey are the calculated mean of the two counts made on the two consecutive survey days each quarter. Species counts include the cumulative total over the course of both survey days. Species and family counts by individual survey day can be found in Appendix A6-1. Also note in all figures the temporal gap between 1999 (year 3), 2001 (year 5), and 2006 (year 10), as well as temporal gaps in pre-restoration data collected by other teams (notated only on the first figure for simplicity, but applicable to all avian figures).

6.2.1 Avian Diversity

Species counts in post-restoration quarterly surveys ranged from 70 to 99, with a mean of 86 species per quarter and a grand total of 168 species. Diversity was generally highest during January and April surveys, reflecting the seasonal arrival of wintering and migratory species each year. Figure 6-2 presents avian species counts by quarter, including the pre-restoration data collected by WRA in 1994 and 1995 by the same method, and MBA (1987 and 1988) and MEC (1989) by similar methods. The mean number of species during the pre-restoration surveys was 78 species, though comparisons should be made with caution due to the varied months during which the surveys were conducted in relation to peak avian usage each year. Considerably more upland bird species were observed during the pre-restoration years, when drier conditions over larger areas existed during some years. Additionally, the landward boundary of some of the pre-restoration surveys may have included uplands that were not surveyed post-restoration, when the installation of a trail system established a more definite site boundary. Pre-restoration surveys recorded unusual species infrequently observed in southern California, typically seen as a single individual, including tundra swan (*Cygnus columbianus*), snow goose (*Chen caerulescens*), bank swallow (*Riparia riparia*), black tern (*Chlidonias niger*) and rose-breasted grosbeak (*Pheucticus ludovicianus*).

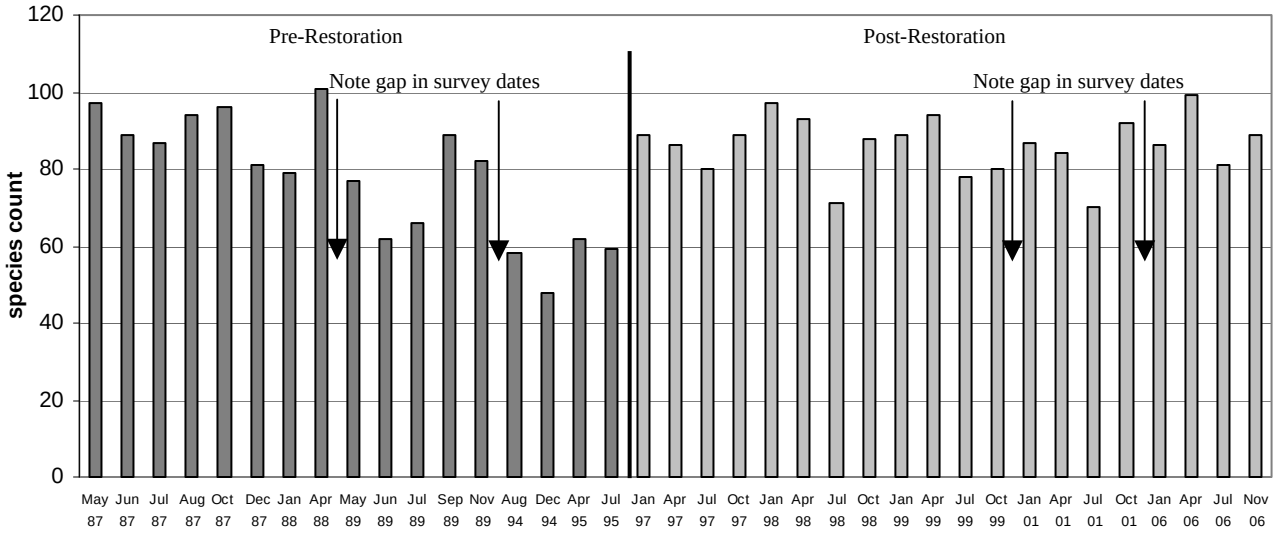


Figure 6-2. Number of species observed during pre- and post-restoration surveys.

Species uncommon to Batiquitos Lagoon recorded post-restoration included Eurasian wigeon (*Anas penelope*), common goldeneye (*Bucephala clangula*), Baikal teal (*Anas formosa*), red-throated loon (*Gavia stellata*), red-necked grebe (*Podiceps grisegena*), red-necked phalarope

(*Phalaropus lobatus*), American bittern (*Botaurus lentiginosus*), reddish egret (*Egretta rufescens*), glaucous-winged gull (*Larus glaucescens*), Thayer's gull (*Larus thayeri*), chipping sparrow (*Spizella passerine*), Lincoln's sparrow (*Melospiza lincolnii*), purple martin (*Progne subis*), warbling vireo (*Vireo gilvus*), Pacific-slope flycatcher (*Empidonax difficilis*), ash-throated flycatcher (*Myiarchus cinerascens*), loggerhead shrike (*Lanius ludovicianus*), western tanager (*Piranga ludoviciana*), blue grosbeak (*Passerina caerulea*), black-headed grosbeak (*Pheucticus melanocephalus*), tricolored blackbird (*Agelaius tricolor*), California thrasher (*Toxostoma redivivum*), American pipit (*Anthus rebuscens*), downy woodpecker (*Picoides pubescens*), northern flicker (*Colaptes auratus*), rufous hummingbird (*Selasphorus rufus*), and Allen's hummingbird (nesting, *Selasphorus sasin*). Relative abundance of each species is shown in a list of species presented in ascending order from least to most abundant in Appendix A6-3. Also observed at the lagoon during another biological monitoring task was the federally endangered least Bell's vireo (*Vireo bellii pusillus*). This individual was observed in Spring 2006, on the north shore of the east basin. The vireo was likely migrating to its breeding grounds and utilizing the willows and adjacent golf course to forage. There are no prior records of this bird at Batiquitos Lagoon (WRA 1995, MEC 1990, MBA 1988, Baumgartel 2006).

A review of avian data collected prior to the restoration indicates that approximately 30 species were recorded over the course of 28 surveys between 1987 and 1996 that were not observed again during post-restoration surveys from 1997 to 2006 (20 surveys). Twenty-two of the 30 species (73%) were upland birds that may have been observed in non-wetland areas present before the restoration. Comparisons are also complicated by methodological variations. The pre-restoration surveys were conducted in various months of the year, while the post-restoration surveys were conducted only in January, April, July, and October of each year and could have missed migratory occurrences of some of these species, most of which were uncommon species. Fifteen species were observed following, but not prior to, the restoration. These were primarily waterfowl and gull species. Appendix A6-4 presents a list of the unique species noted before and after the restoration.

6.2.2 Avian Abundance

Seasonal migration patterns were the major factor driving post-restoration avian abundance within the lagoon. The mean number of birds observed per survey ranged from 1,151 (July 2006) to 7,953 (January 2006) (Figure 6-3). Typically, the greatest numbers of individuals post-restoration were observed during the October and January quarters during each year, with lower numbers in April and July. The mean number of birds in January, April, July, and October over the five survey years was 5,805, 3,392, 1,993, and 4,049, respectively. The highest mean number of individuals per survey was in January 2006 (7,953), as compared with the second highest in January 1998 (7,617), and the third highest (6,882) in January 1997 (Table 6-1). In addition, the highest number of families (30) and the highest number of species (99) were recorded, in July and April 2006, respectively (Table 6-1).

Western sandpiper (*Calidris mauri*) were present in the highest numbers, followed by American coot (*Fulica americana*), ruddy duck (*Oxyura jamaicensis*), and dowitcher (*Limnodromus* sp.). Only the month of July was surveyed consistently between the pre- and post-restoration assessment, and abundances were higher in July surveys during the pre-restoration period due to

high numbers of western sandpiper (July 1987 and 1989) and American coot (July 1989). Comparisons between pre- and post-restoration abundances will be discussed in the following sections, though MBA (1988) cautions that the pre-restoration data should be used carefully when making comparisons between years due to the effect of high variability in water levels, extent of winter rains, and timing of periodic lagoon mouth openings on the results of individual surveys. As an example, they point to a conversion of habitat availability between May and June 1987 from 14, 84, and 397 acres of mudflat, shallow water and deep water, respectively, in May to 114, 208, and 75 acres of the same habitats in June. Water levels during the 1989, 1994, and 1995 surveys were noted to be substantially higher than in 1987 (MEC 1990, WRA 1995). Higher water levels generally provided better habitat for diving birds and herons, with lower amounts of mudflat habitat available for use by foraging shorebirds.

Species observed were divided into one of eight ecological guilds (small shorebirds, large shorebirds, wading/marshbirds, aerial fish foragers, waterfowl, gulls, raptors, and upland birds) based on foraging behavior, life history traits, and/or taxonomic affiliation (Appendix A6-5). The effect of the restoration project on usage by shorebirds and waterfowl was of particular interest. Trends in the abundance of these and all other guilds over time are presented below, with charts of all eight guilds included in the appendices.

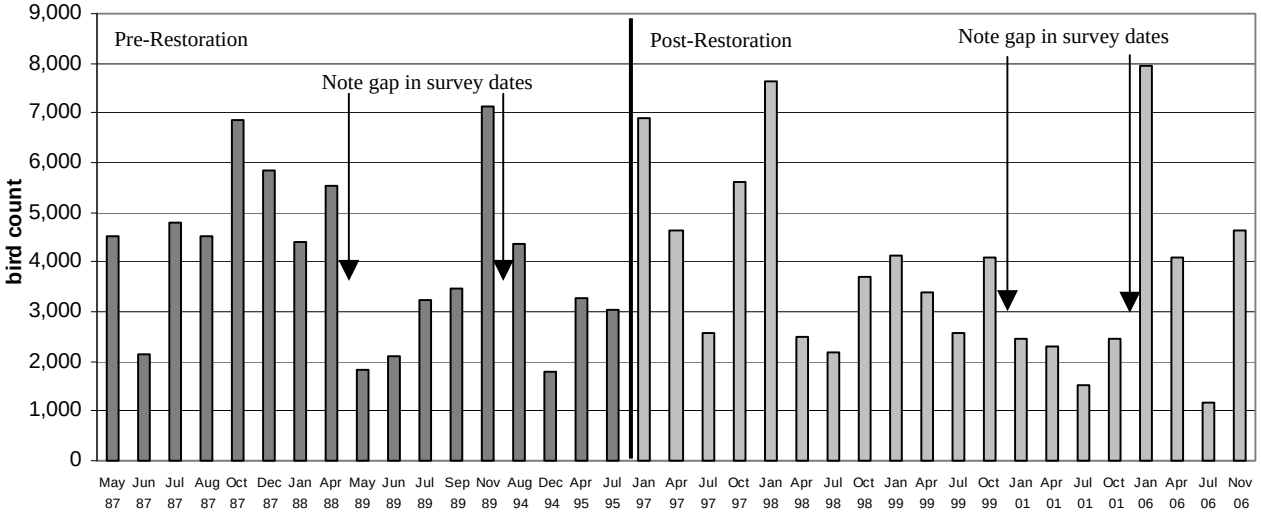


Figure 6-3. Number of birds observed during pre- and post-restoration surveys.

Waterfowl

Post-restoration waterfowl were observed in the greatest numbers during January surveys each year, with the most counted immediately following the lagoon opening, then a reduced number in subsequent years, with a return to higher numbers in 2006 (Figure 6-4).

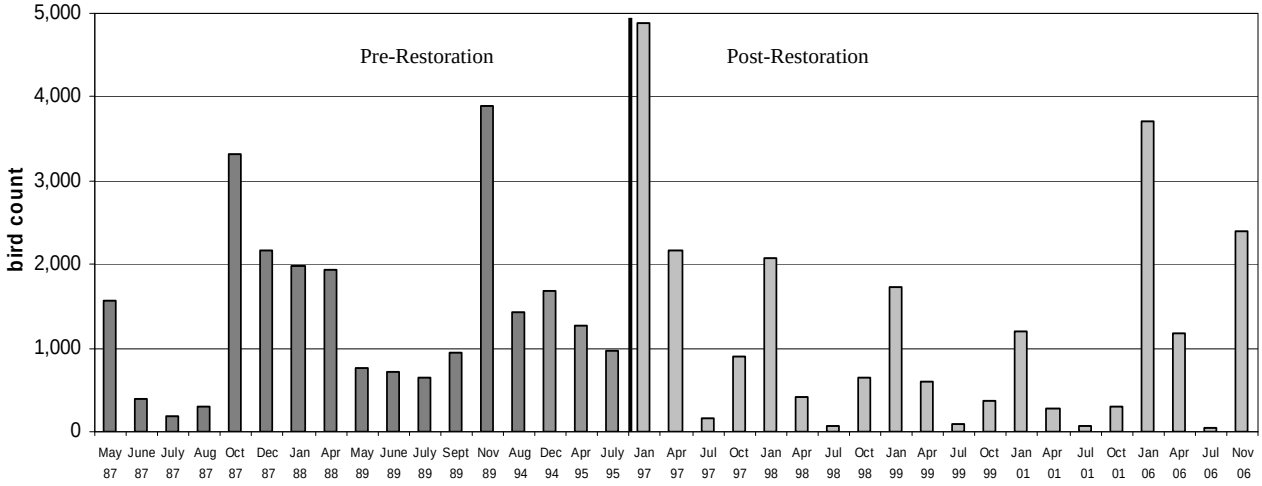


Figure 6-4. Number of waterfowl observed during pre- and post-restoration surveys.

During post-restoration surveys, the most abundant bird in the waterfowl group was American coot (a rail), which accounted for between 11% and 57% of the total waterfowl counted in all January, April, and October months. They were generally absent in July each year, likely having moved to freshwater during the breeding season. Interestingly, reviewing waterfowl trends with American coot removed revealed a nearly identical trend in waterfowl abundance as that shown in Figure 6-4. Listed in order of decreasing abundance after American coot were ruddy duck, American wigeon (*Anas americana)*, northern pintail (*Anas acuta*), gadwall (*Anas strepera*), green-winged teal (*Anas crecca*), mallard (*Anas platyrhynchos*), redhead (*Aythya americana*), northern shoveler (*Anas clypeata*), and scaup (*Aythya* sp.). In regular, but lower, numbers were bufflehead (*Bucephala albeola*), cinnamon teal (*Anas cyanoptera*), canvasback (*Aythya valisineria*), surf scoter (*Melanitta perspicillata*), blue-winged teal (*Anas discors*), and ring-necked duck (*Aythya collaris*). Seen on only one or two occasions were Eurasian wigeon, common goldeneye, and Baikal teal. Other species grouped in with the waterfowl were grebes (6 species), cormorants (1 species), mergansers (2 species), loons (3 species), geese (2 species), and American white pelican (*Pelecanus erythrorhynchos*), which was included in this guild due to its foraging technique.

The 1987, 1989, 1994, and 1995 pre-restoration surveys reported waterfowl with less distinct seasonal patterns than those seen post-restoration. Higher pre-restoration summer waterfowl numbers were driven by American coot, ruddy duck, and gadwall which were abundant at the lagoon during most months when water levels were high.

It is useful to examine waterfowl trends at the lagoon by breaking the guild apart based on foraging strategy. Dabbling ducks (genus *Anas*) generally forage in shallow water by tipping up to reach bottom vegetation or by browsing at or near the water surface for aquatic vegetation, seeds, and insects. Figure 6-5 presents the abundance of dabbling ducks at the lagoon pre- and post-restoration, which was highly variable over the 20-year period. Table 6-2 shows dabbling duck counts by species. It is important to note in these graphics that the pre-restoration surveys were not conducted on the same quarterly schedule as the post-restoration surveys, and therefore

do not reflect annual migratory patterns as clearly. These data are presented graphically by species in Appendix A6-6. American coot has been added to that appendix figure to show their relative abundance among the dabbling ducks.

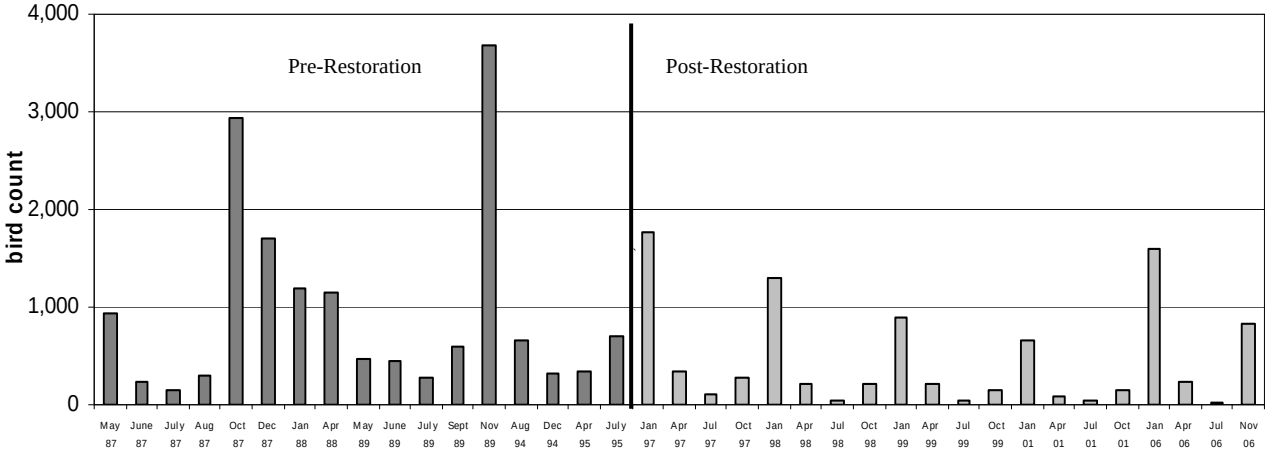


Figure 6-5. Number of dabbling ducks observed during pre- and post-restoration surveys.

The pre-restoration dabbling duck guild was dominated at times by gadwall and mallard, and in other years by northern shoveler and northern pintail. In the first post-restoration survey (January 1997), the most abundant dabbling ducks were northern pintail and American wigeon. Pintail were even more abundant in 1998 and then occurred in lower numbers in the years that followed (Table 6-2). American wigeon were seen in much lower numbers in 1998, 1999, and 2001, but were observed in high abundance again in 2006, with 786 individuals, and were by far the most abundant duck that quarter. Gadwall and green-winged teal were the next most abundant dabblers, followed by mallards. Mallard abundance, however, declined steadily from 1997 to 2006, from 308 in January 1997 to only 15 in 2006.

Due to the irregular timing of surveys within this 20-year data set, conclusions about pre- and post-restoration trends in abundance by species should be drawn carefully. In general, northern shoveler was more common and abundant in the 1987 and 1989 surveys, then found in relatively smaller numbers following the restoration. Gadwall, mallards, and cinnamon teal were also more abundant prior to the restoration. Pre-restoration dabbling duck usage was likely related to the water depth at the time of each survey, the duration that the water had been ponded, and the related food availability. Post-restoration, green-winged teal and American wigeon were more commonly seen and in higher numbers.

Table 6-2. Dabbling duck abundance by species during pre- and post-restoration surveys (1987-2006).

		Green-winged Teal	American Wigeon	Blue-winged Teal	Cinnamon Teal	Gadwall	Mallard	Northern Pintail	Northern Shoveler
Pre-Restoration	May 87[1]	12	7	5	221	426	251	3	3
	June 87[1]	0	0	0	47	43	140	2	0
	July 87[1]	0	0	0	17	5	125	0	0
	Aug 87[1]	1	10	0	65	19	155	32	10
	Oct 87[1]	363	312	2	69	224	73	652	1244
	Dec 87[1]	48	177	0	7	84	67	276	1049
	Jan 88[1]	29	0	0	37	6	30	19	1068
	Apr 88[1]	10	42	1	143	324	151	2	468
	May 89[2]	0	2	0	29	185	240	3	2
	June 89[2]	0	0	0	51	368	35	0	0
	July 89[2]	0	0	0	26	147	92	0	0
	Sept 89[2]	9	133	0	138	37	111	38	120
	Nov 89[2]	100	353	0	50	63	65	1120	1927
	Aug 94[3]	0	0	9	16	0	564	73	0
	Dec 94[3]	5	45	3	2	10	0	6	246
	Apr 95[3]	0	1	0	5	171	100	2	60
	July 95[3]	1	0	0	3	683	9	0	0
Post-Restoration	Jan 97	100	420	0	49	70	308	516	307
	Apr 97	11	4	0	44	144	108	0	35
	Jul 97	0	0	0	4	12	86	0	0
	Oct 97	42	28	0	19	0	65	28	106
	Jan 98	231	41	0	11	40	66	830	89
	Apr 98	2	28	0	14	111	60	0	7
	Jul 98	0	0	0	1	1	35	0	0
	Oct 98	31	8	4	5	7	33	37	92
	Jan 99	201	263	1	16	89	15	287	31
	Apr 99	13	10	0	11	119	57	0	2
	Jul 99	1	0	0	0	6	47	0	0
	Oct 99	39	5	2	1	6	17	23	49
	Jan 01	94	194	0	5	143	5	184	46
	Apr 01	1	0	0	12	51	30	0	1
	Jul 01	0	0	0	0	40	9	0	0
	Oct 01	24	94	2	4	3	5	5	14
	Jan 06	244	786	0	44	222	15	260	37
	Apr 06	44	25	32	17	63	22	2	30
	Jul 06	0	0	0	1	12	16	0	0
	Nov 06	37	479	9	14	178	11	65	32

[1] Michael Brandman Associates, Inc. 1988
[2] MEC 1990
[3] WRA 1995

Diving waterfowl dive underwater to obtain seeds, aquatic plants, fish, insects, and other invertebrates. The trends in diving waterfowl are presented in Figure 6-6, which includes cormorants, grebes, and diving ducks (ruddy duck, bufflehead, redhead, canvasback, ring-necked duck, common goldeneye, surf scoter, scaup, mergansers, and loons).

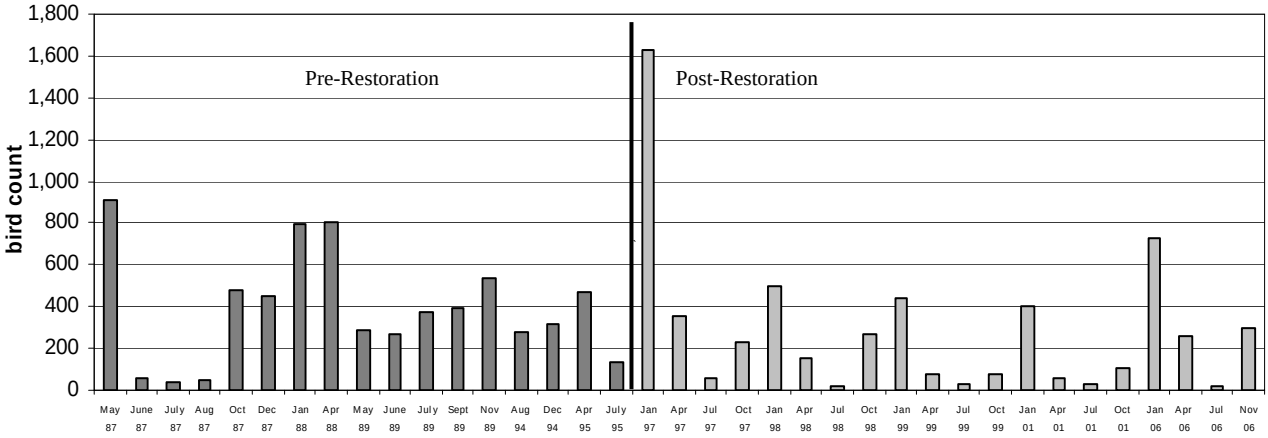


Figure 6-6. Number of diving waterfowl (diving ducks, cormorants, and grebes) observed during pre- and post-restoration surveys.

During all pre-restoration surveys, ruddy duck represented 62% to 100% of the diving ducks, with primarily redhead making up the remainder (Table 6-3). The diving duck abundances pre-restoration closely mirror the availability of deep water habitat for foraging. As noted above, there was a dramatic drop in water level between May and June 1987, which persisted through the summer months, with large expanses of deep water again available in winter and in later survey years (1989, 1994, and 1995).

Post-restoration, a 20-year high in January 1997 was attributable to unusually high numbers of redhead and ruddy duck, which made up 93% of the diving ducks. Canvasback, which was observed in small numbers pre-restoration, increased in most January surveys post-restoration. January 2006 had high numbers of scaup, which had been in low abundance for much of the study period. Only one individual loon, Pacific loon (*Gavia pacifica*), was observed prior to restoration, while both common loon (*Gavia immer*) and Pacific loon were regularly seen following restoration, in addition to a single red-throated loon in April 1999. Grebes were present both before and after restoration, with slightly more pied-billed grebes (*Podilymbus podiceps*) and eared grebes (*Podiceps nigricollis*) before, and more horned grebes (*Podiceps auritus*) after. Charts presenting the abundance trends of the dominant diving ducks by species are included in Appendix A6-6.

Table 6-3. Diving duck abundance by species during pre- and post-restoration surveys (1987-2006).

		Bufflehead	Redhead	Ruddy Duck	Scaup species	Surf Scoter	Canvasback	Ring-necked Duck	Common Goldeneye
Pre-Restoration	May 87[1]	11	75	663	7	9	0	0	0
	June 87[1]	0	0	28	0	7	0	0	0
	July 87[1]	0	0	21	0	1	0	0	0
	Aug 87[1]	0	11	17	0	0	0	0	0
	Oct 87[1]	0	85	306	22	1	0	0	0
	Dec 87[1]	24	23	308	10	0	0	0	0
	Jan 88[1]	132	11	516	7	0	2	0	0
	Apr 88[1]	9	51	605	11	7	0	0	0
	May 89[2]	0	59	169	0	0	0	0	0
	June 89[2]	0	42	143	0	0	1	0	0
	July 89[2]	0	28	255	0	0	0	0	0
	Sept 89[2]	0	3	275	0	0	0	0	0
	Nov 89[2]	10	19	233	53	0	3	0	0
	Aug 94[3]	0	0	162	0	0	0	0	0
	Dec 94[3]	3	13	215	42	0	0	0	0
	Apr 95[3]	4	7	391	0	0	1	0	0
	July 95[3]	0	21	48	0	0	9	0	0
Post-Restoration	Jan 97	27	637	791	78	0	0	1	0
	Apr 97	39	2	217	18	0	0	0	0
	Jul 97	0	0	29	0	0	0	0	0
	Oct 97	8	70	87	1	1	0	0	0
	Jan 98	58	137	155	43	3	29	0	0
	Apr 98	1	1	35	2	68	0	0	0
	Jul 98	0	0	10	0	8	0	0	0
	Oct 98	0	0	189	44	0	0	0	0
	Jan 99	56	0	304	42	0	1	7	0
	Apr 99	0	0	27	5	0	0	0	0
	Jul 99	0	0	9	0	1	0	0	0
	Oct 99	0	0	50	1	0	0	0	0
	Jan 01	62	0	109	28	0	114	6	1
	Apr 01	0	0	6	1	0	0	0	0
	Jul 01	0	0	1	0	0	0	0	0
	Oct 01	0	0	50	1	0	0	0	0
	Jan 06	93	72	189	201	1	55	0	0
	Apr 06	3	6	204	9	0	6	0	0
	Jul 06	0	1	0	0	0	0	0	0
	Nov 06	37	28	98	48	0	4	0	0

[1] Michael Brandman Associates, Inc. 1988
[2] MEC 1990
[3] WRA 1995

Shorebirds

Shorebirds were divided into two guilds: small shorebirds, such as western sandpiper, and large shorebirds, such as marbled godwit (*Limosa fedoa*) (Appendix A6-5). Abundance trends for both guilds combined are presented in Figure 6-7. Shorebirds trends did not show a clear annual pattern during post-restoration surveys. In some years, abundance peaked in January, while in others, October or April had the highest numbers, likely the result of survey timing in relation to seasonal and daily migratory events. In the July surveys of 1997, 1998, and 1999, there were considerable numbers of shorebirds present at the lagoon, with notably less in the July surveys of 2001 and 2006.

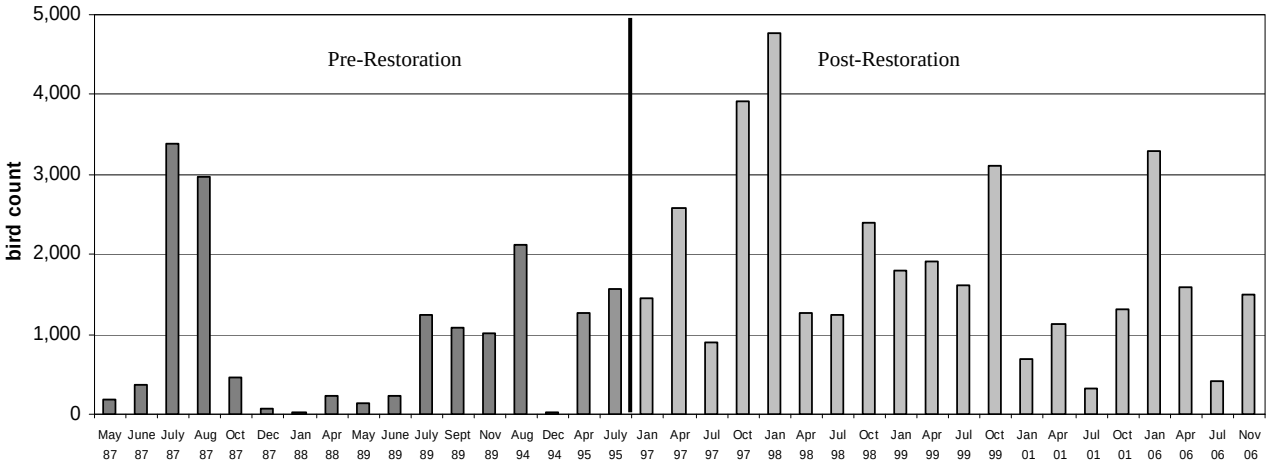


Figure 6-7. Number of shorebirds observed during pre- and post-restoration surveys.

During the post-restoration surveys, small shorebirds made up 82% of the total shorebirds observed. The most abundant small shorebirds were western sandpiper and least sandpiper (*Calidris minutilla*). Because many of the sandpipers were observed from great distances, were backlit, or were in flight, considerable numbers of sandpipers were identified simply as unidentified sandpiper. These birds were either western or least sandpiper. The next most abundant small shorebird was semi-palmated plover (*Charadrius semipalmatus*), followed in descending order by killdeer (*Charadrius vociferous*), black-bellied plover (*Pluvialis squatarola*), sanderling (*Calidris alba*), western snowy plover, dunlin (*Calidris alpine*), and spotted sandpiper (*Actitis macularius*). Observed on only a few occasions were ruddy turnstone (*Arenaria interpres*), black turnstone (*Arenaria melanocephala*), and red-necked phalarope. A chart showing trends in small shorebird abundance by species is included in Appendix A6-6.

The number of small shorebirds post-restoration was high in 1997, 1998, and 2006 and slightly lower in 2001. Small shorebird usage during the pre-restoration period was highly variable and generally peaked in the summer months. Suitable mudflat habitat was not consistently available during pre-restoration winter and spring months to attract large numbers of shorebirds.

During post-restoration surveys, the most abundant large shorebirds were dowitchers, which were generally not broken out into long-billed (*Limnodromus scolopaceus*) and short-billed dowitcher (*Limnodromus griseus*) due again to the distance of the observers from the birds most

of the time. Identification was possible in some cases where there was opportunity for close scrutiny. Also occurring in significant and regular numbers were willet (*Tringa semipalmata*), marbled godwit, American avocet (*Recurvirostra americana*), and black-necked stilt (*Himantopus himantopus*). Both willets and marbled godwits were present in low numbers initially, with an upward trend in numbers over the 10-year study period. In smaller numbers were whimbrel (*Numenius phaeopus*), long-billed curlew (*Numenius americanus*), greater (*Tringa melanoleuca*) and lesser yellowlegs (*Tringa flavipes*), and occasionally common snipe (*Gallinago gallinago*).

Prior to restoration, American avocet, black-necked stilt, and yellowlegs were more abundant. The American avocet and black-necked stilt were observed in high numbers and breeding during the spring and summer pre-restoration seasons and declined rapidly post-restoration, when some nesting habitat was lost to periodic tidal inundation. Willet, marbled godwit, whimbrel, and long-billed curlew were not seen in great numbers until after the restoration. A chart showing trends in the large shorebird abundance by species is included in Appendix A6-6.

Wading/Marshbirds

The wading/marshbird guild was represented by 12 species following the restoration, with snowy egret (*Egretta thula*), great egret (*Ardea alba*), and great blue heron (*Ardea herodias*) most abundant and present year-round. Present seasonally and regularly were green heron (*Butorides virescens*), sora (*Porzana carolina*), and black-crowned night heron (*Nycticorax nycticorax*) (Appendix A6-2). Observed occasionally and in low numbers were white-faced ibis (*Plegadis chihi*), Virginia rail (*Rallus limicola*), common moorhen (*Gallinula chloropus*), American bittern, cattle egret (*Bubulcus ibis*), and a single juvenile reddish egret. A heron rookery was established along the north shore of the lagoon in 1999. By 2006, the rookery was well established and included snowy egret, great egret, and great blue heron.

There was an overall decrease in wading/marsh birds in post-restoration surveys when compared to pre-restoration numbers. The pre-restoration surveys were highly variable; however, there are some differences that do stand out. White-faced ibis, which were observed in large groups in the fall and spring pre-restoration, showed the greatest decline, with only a small number being observed post-restoration. The black-crowned night heron and great egret also appears to have declined. Snowy egret remained similar but was observed in very large numbers during two pre-restoration surveys (May 1987 and August 1994).

Light-footed clapper rail (*Rallus longirostris levipes*) were first observed during the surveys in July 2001 in a planted patch of cordgrass (*Spartina foliosa*) in the central basin, although their presence was known earlier in the east basin by their calls heard outside of formal survey periods (see Chapter 7).

Raptors

Following restoration, Batiquitos Lagoon supported a diverse community of raptors, with four to nine species commonly observed during each survey (Appendix A6-2). These included northern harrier (*Circus cyaneus*), red-shouldered hawk (*Buteo lineatus*), red-tailed hawk (*Buteo jamaicensis*), sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*),

merlin (*Falco columbarius*), American kestrel (*Falco sparverius*), peregrine falcon (*Falco peregrinus*), white-tailed kite (*Elanus leucurus*), osprey (*Pandion haliaetus*), and turkey vulture (*Cathartes aura*). A pair of white-tailed kite nested in what may have been their existing, pre-restoration territory at the far eastern end of the lagoon in riparian habitat. Copulation and juveniles were observed. As many as five osprey were observed soaring together at one time, as well as groups of three perching together. However, no osprey nesting activity has been observed at Batiquitos Lagoon. Two male merlin were observed foraging together in January 1999, with only single birds on all other occasions. The peregrine falcon was observed repeatedly during 1997 (with two together in January 1997) and then was not seen again until 2006, when a single individual was observed foraging throughout the site in April and October. Prior to the restoration, no peregrine falcon, osprey, merlin, or turkey vulture were reported in the MBA, MEC, and WRA studies. A chart showing trends in raptor abundance by species before and after restoration is included in Appendix A6-6.

Aerial Fish Foragers

The aerial fish forager guild included terns, belted kingfisher (*Megaceryl alcyon*), and California brown pelican (*Pelecanus occidentalis californicus*). Following restoration, seven species of tern were observed, with Forster's tern (*Sterna forsteri*) most abundant (Appendix A6-2). California least tern numbers peaked during the first year of monitoring, then were greatly reduced but relatively consistent in the following survey years. Least tern will be discussed further in the following chapter. Of note was the spike in numbers of elegant tern (*Thalasseus elegans*) in April 2006, when up to 630 individuals were observed loafing on the flood shoal in the central basin (Zone 6), and a peak in Forster's tern numbers in January 2006, when a large group was also loafing on the shoal. Forster's tern historically nested at Batiquitos (first in 1987) in the west basin (1987 and 1995) and central basin (1998) (MBA 1988). They were observed nesting post-restoration in the central basin in 1997, in the salt marsh just east of the railroad tracks. Disturbance from uncontrolled access to the site by fisherman may have caused the Forster's terns to abandon the nest site in subsequent years. They were not observed nesting in subsequent surveys until 2006, when an estimated 30 pair of Forster's tern were recorded nesting in the same location. It is possible that nesting occurred between 2003 and 2005 as well, when no avian monitoring was conducted. No elegant tern nesting was observed at Batiquitos during the monitoring program, despite their presence in large numbers during some spring and summer months. Over the 10-year monitoring period, the number of Caspian tern (*Hydroprogne caspia*) increased, black skimmer (*Rynchops niger*) decreased slightly, and royal tern (*Thalasseus maximus*) and common tern (*Sterna hirundo*) were seen only occasionally and in low numbers.

Prior to the restoration all aerial fish foragers were seen in lower numbers than post-restoration, with the exception of Forster's tern, which had a single peak in September 1989. One, two, or no elegant terns were seen in pre-restoration surveys in 1987, 1988, 1989, and 1994, with 98 observed in April 1995. Data collected by Batiquitos Lagoon Foundation member M. Baumgartel found similar low numbers of elegant terns pre-restoration years and higher numbers post-restoration in 1997. A chart showing trends in tern abundance by species is included in Appendix A6-6.

Gulls

Gulls were represented by nine species post-restoration, with ring-billed gull (*Larus delawarensis*) most abundant and occurring in high numbers in January surveys, followed by California gull (*Larus californicus*) and western gull (*Larus occidentalis*). The number of western gull increased throughout the post-restoration monitoring period. Much less common and irregular were Bonaparte's gull (*Chroicocephalus philadelpia*), Heermann's gull (*Larus heermanni*), mew gull (*Larus canus*), herring gull (*Larus argentatus*), glaucous-winged gull, and Thayer's gull (Appendix A6-2). Prior to restoration, gulls were generally less abundant, with the exception of California gull, which were observed in high numbers during two winter surveys. Mew, glaucous-winged, and Thayer's gulls were not noted pre-restoration. A chart showing trends in the abundance of dominant gull species is included in Appendix A6-6.

Upland Birds

Upland birds were a large group that included 73 species post-restoration, such as sparrows, flycatchers, corvids, swallows, and others, all of which occur on the margins of the lagoon and, as a group, are not restricted to marsh habitats, though they may utilize marsh habitats heavily at Batiquitos Lagoon (Appendix A6-2). Note that Belding's Savannah sparrow has been included in this guild with the other sparrows, though this race of Savannah sparrow generally occurs in non-upland marsh habitat. Excluding the Belding's Savannah sparrow, the most abundant upland birds were bushtit (*Psaltriparus minimus*), cliff swallow (*Petrochelidon pyrrhonota),* house finch (*Carpodacus mexicanus*), common yellowthroat (*Geothlypis trichas*), marsh wren (*Cistothorus palustris*), mourning dove (*Zenaida macroura*), and Anna's hummingbird (*Calypte anna*). Not observed during surveys, but seen at the lagoon in July 1997, was a great-tailed grackle (*Quiscalus mexicanus*), not native to the area but an invading species from Sonora or southern Arizona. The San Diego County Bird Atlas lists probable great-tailed grackle breeding at Batiquitos Lagoon (Unitt 2004). Comparisons to upland birds observed prior to restoration are difficult due to the larger upland areas surveyed in many of those surveys.

6.2.3 Nesting Activity

Although an assessment of the breeding status of the birds at Batiquitos Lagoon was not part of the monitoring program, abundant observational data on breeding activity were collected over the life of the post-restoration monitoring program. Copulation or nesting activity was directly observed in white-tailed kite, red-tailed hawk, Allen's hummingbird, Belding's Savannah sparrow, killdeer, western snowy plover, Forster's tern, Caspian tern, California least tern, black skimmer, snowy egret, great blue heron, red-winged blackbird, gadwall, mallard, bushtit, black-necked stilt, American avocet, mourning dove, horned lark (*Eremophila alpestris*), cliff swallows, common yellowthroat (feeding a brown-headed cowbird [*Molothrus ater*] chick), and song sparrow (*Melospiza melodia*). Behavioral indicators suggested nesting by many other species, primarily upland birds, including the California gnatcatcher (*Polioptila californica californica*). Comprehensive information on avian breeding at Batiquitos Lagoon can be found in Unitt (2004).

6.2.4 Avian Distribution Patterns

Post-restoration avian distribution patterns within Batiquitos Lagoon were related primarily to preferential usage of habitats within the lagoon. Habitat availability and quality changed over

time as the lagoon transitioned to a tidal system, with gradually shifting acreages of mudflat, sand bar, coastal salt marsh, cordgrass, freshwater marsh, and other communities preferred by various avian species for foraging, loafing, and nesting.

The western basin (Zone 7) of Batiquitos Lagoon is relatively small, under full tidal influence, and has experienced dramatic physical changes between 1997 and 2006. Following the restoration, processes related to avian usage included the loss of most of the pickleweed (*Sarcocornia pacifica*) marsh on the north side of the basin through erosion, the loss of coastal sage scrub through the erosion of the abandoned railroad spur, the development of a large eelgrass (*Zostera marina*) bed in the subtidal areas, and the accretion of sand on the eastern and western shores of the basin, which increased loafing areas and reduced open water. The most abundant species in this zone were western sandpiper, least tern, house finch, and mourning dove. General trends over the 10-year post-restoration period showed a decline in usage of the west basin by waterfowl and an increase by large shorebirds, corresponding to the loss of open water and increases in intertidal sandy areas for foraging large shorebirds. Brown pelicans and gulls frequently used the sand bar on the east shore of the basin for loafing. High numbers of least tern were observed loafing and foraging in this basin in July 1997, with lower numbers in 1998, 1999, and 2001, and the lowest count in the 10-year period in 2006.

Prior to restoration, much higher densities of birds were documented using this zone. In 1989, the zone was described as having an expanse of open water and mudflats, dotted with small islands and noted to have by far the greatest concentration of birds in the lagoon (MEC 1990).

The central basin of the lagoon (Zone 6) is primarily open water, fringed by salt marsh. The salt marsh was originally pickleweed dominated following the restoration, but has converted in many areas to cordgrass (see habitat maps in Chapter 3). The formation of flood shoals dramatically increased loafing habitat for terns, cormorants, pelicans, and shorebirds, which prefer the shoals to the shoreline areas, likely due to their isolation from the shore. Over the 10-year post-restoration monitoring period, usage of the central basin by gulls and aerial fish foragers increased, while usage by waterfowl and shorebirds decreased. As cordgrass habitat expanded, light-footed clapper rail occupied several areas on the western and northern shore of the basin by 2006. A series of telephone and power lines extend over the central basin, which provided foraging perches for osprey and belted kingfisher, as well as loafing and roosting perches for double-crested cormorant (*Phalacrocorax auritus*).

Zone 6 was more heavily used pre-restoration by a wider variety of guilds and species, including large numbers of coots, ducks, pelicans, terns, and gulls. Herons and large aggregations of red-necked phalaropes were also common (WRA 1995). This basin generally had a more diverse, though less predictable, mix of shallow water, mudflat, and deeper water habitats than post-restoration.

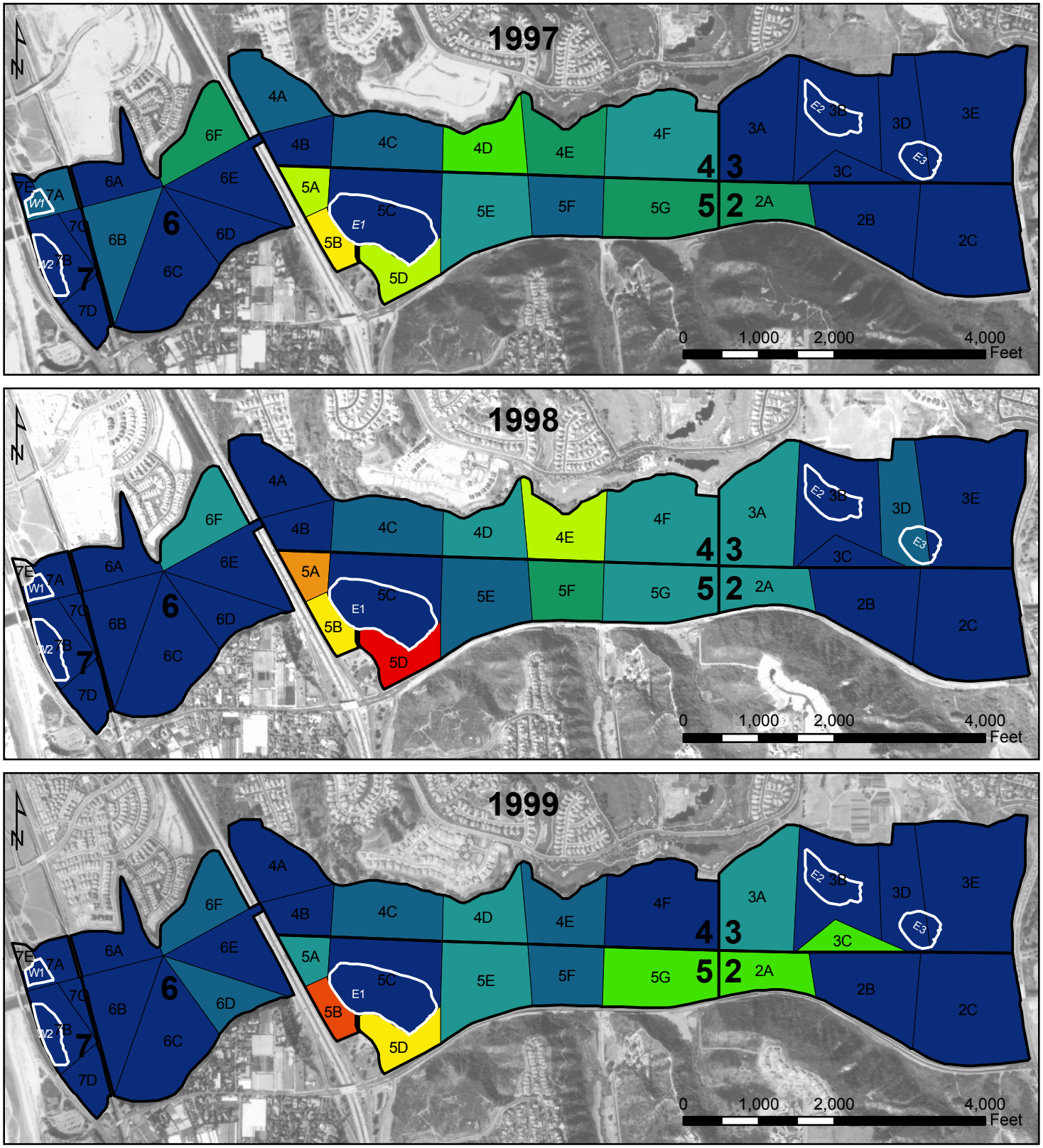
The east basin (Zones 2, 3, 4, and 5) is the largest of the three, with the most diverse habitats and supporting the highest densities of birds post-restoration. The extensive pickleweed marsh at the northeastern end of the lagoon has remained largely unchanged over the 10-year period and continues to support large numbers of Belding's Savannah sparrows. Input of material lagoon-

wide from both the ocean and upstream have had notable effects on avian habitat availability in the east basin. Loss of tidal prism resulting from the sand shoals in the outer basins prevents the lagoon from fully draining at low tides, allowing the expansion of cordgrass up into previously pickleweed dominated marsh and the conversion of some intertidal mudflat to open water. However, the accretion of sediment in both the eastern and western ends of the basin from the watershed upstream has created mudflat in some areas that were previously open water under most tidal conditions. The area just east of the Interstate 5 (I-5) bridge, near the Nature Center, is now intertidal, with large expanses of exposed mudflat attracting large aggregations of shorebirds and waterfowl in recent years. The east basin now supports large beds of eelgrass, which were clearly favored by American coot, with American wigeon and northern shoveler regularly foraging in eelgrass at the surface. On mudflats that had exposed eelgrass at low tide, it was often observed that many shorebirds appeared to preferentially forage in the exposed eelgrass.

Trends in the spatial usage of the lagoon by various guilds are reflective of the habitats available in each survey subzone, as well as the species composition within the guild. A series of avian density (birds/acre) figures follow. It is important to note that density calculations in these figures include the entire acreage of the subzone, including all habitats, which can bias the density calculations in cases where disproportionate amounts of suitable habitat for a given guild are present within a subzone. For example, subzones such as 5C, which include a large nesting site, contain a large expanse of habitat that is unused by all but a few avian species, effectively diluting the density of birds using the small areas of open water habitat. However, these biases persist from year to year, allowing inter-annual comparisons to be made.

The great majority of birds (77%) observed during the post-restoration monitoring period from 1997 to 2006 belonged to either the shorebird or waterfowl guilds. Figure 6-8 presents the density of small and large shorebirds combined (birds/acre) within each subzone by year. Intertidal mudflat, the habitat favored by shorebirds, declined in overall acreage in the years following the restoration. This was due to expansion of pickleweed and cordgrass marsh onto the mudflat, as well as the reduced frequency of low tide conditions related to accumulation of flood shoals in the west and central basins. In the early years following the restoration (1997, 1998, and 1999), shorebirds were most abundant on the open mudflats around the E-1 nesting site in subzones 5A, 5B, and 5D (Figure 6-7). With rapid expansion of cordgrass across the mudflat by 2001, fewer shorebirds were observed within these subzones, with the lowest usage occurring by 2006, when nearly the entire mudflat had been colonized by cordgrass (Figure 6-7 and habitat maps in Chapter 3 for 1997-2006). Use of the north shore of the central basin (subzone 6F) declined steadily over the length of the monitoring program as well, as the mudflat was replaced by pickleweed and cordgrass dominated salt marsh habitats. With the loss of mudflat in the later years of the monitoring program, shorebird use shifted to other areas with bare mudflat still available, such as the west basin of the lagoon, the north shore of the east basin, and the tip of 5A.

Usage of the lagoon by subzone by the waterfowl guild is presented in Figure 6-9 and shows the most use in the east basin, with little use of the west and central basins. Subzone 2A on the southeastern shore of the east basin was consistently the most used subzone by both diving and

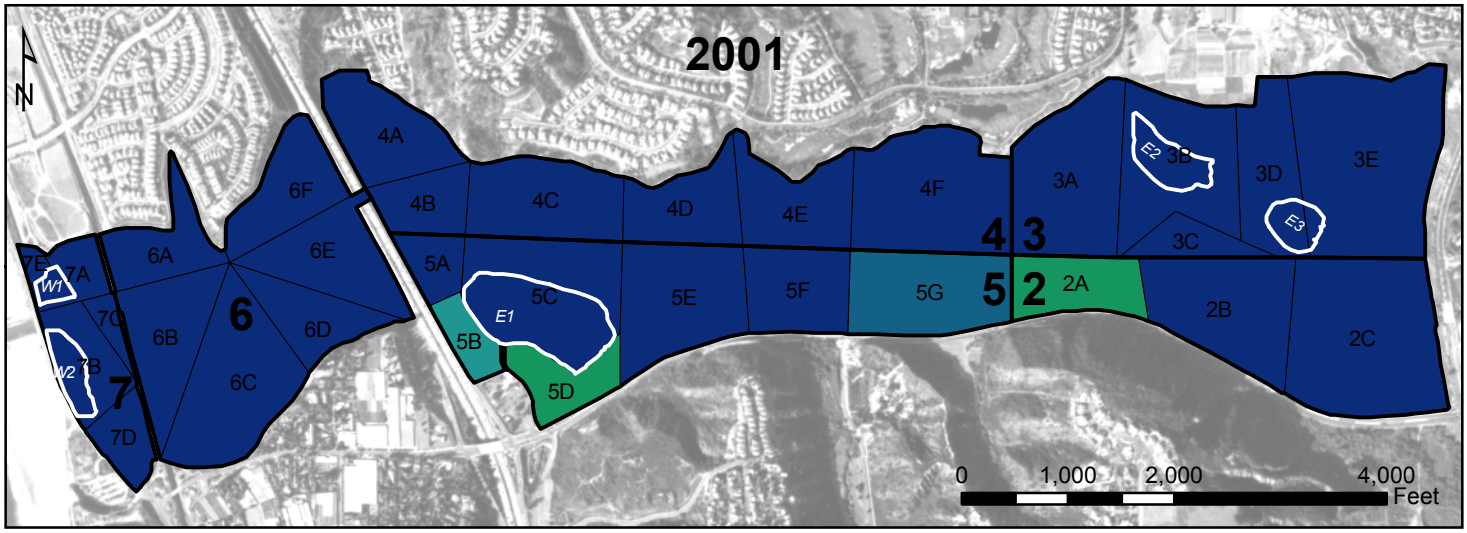


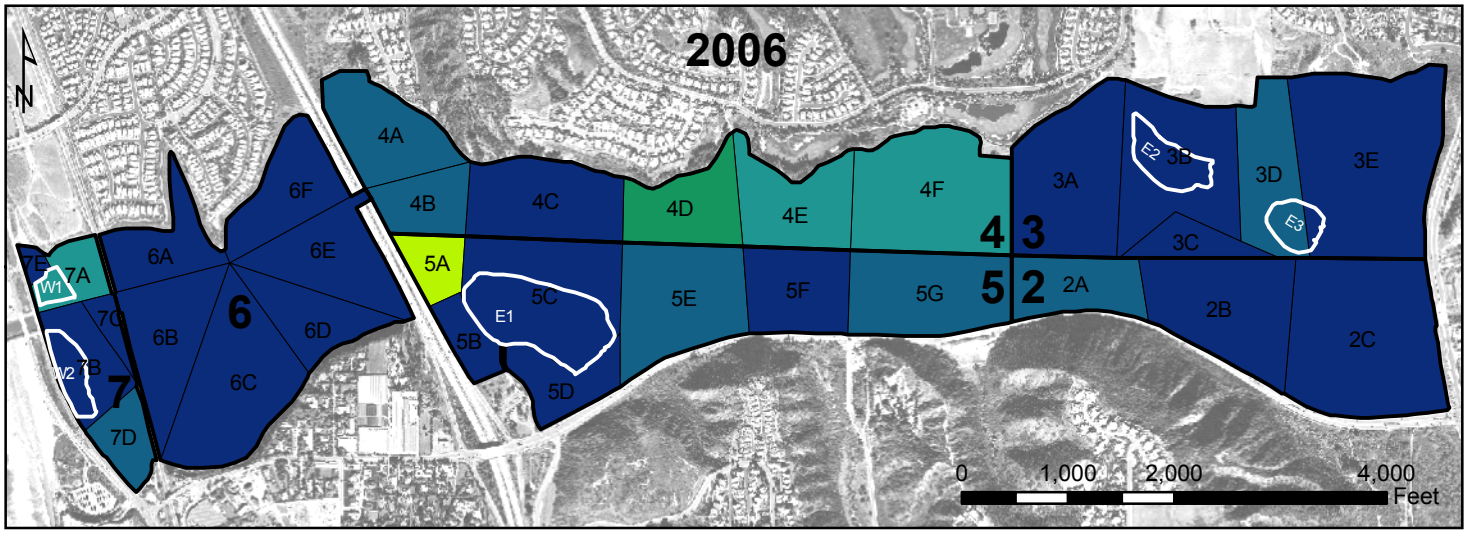
Small and large shorebird density (birds/acre) by subzone by year

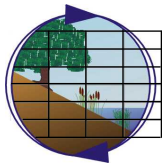
Figure 6-8a

Merkel & Associates, Inc.

This Page Intentionally Left Blank



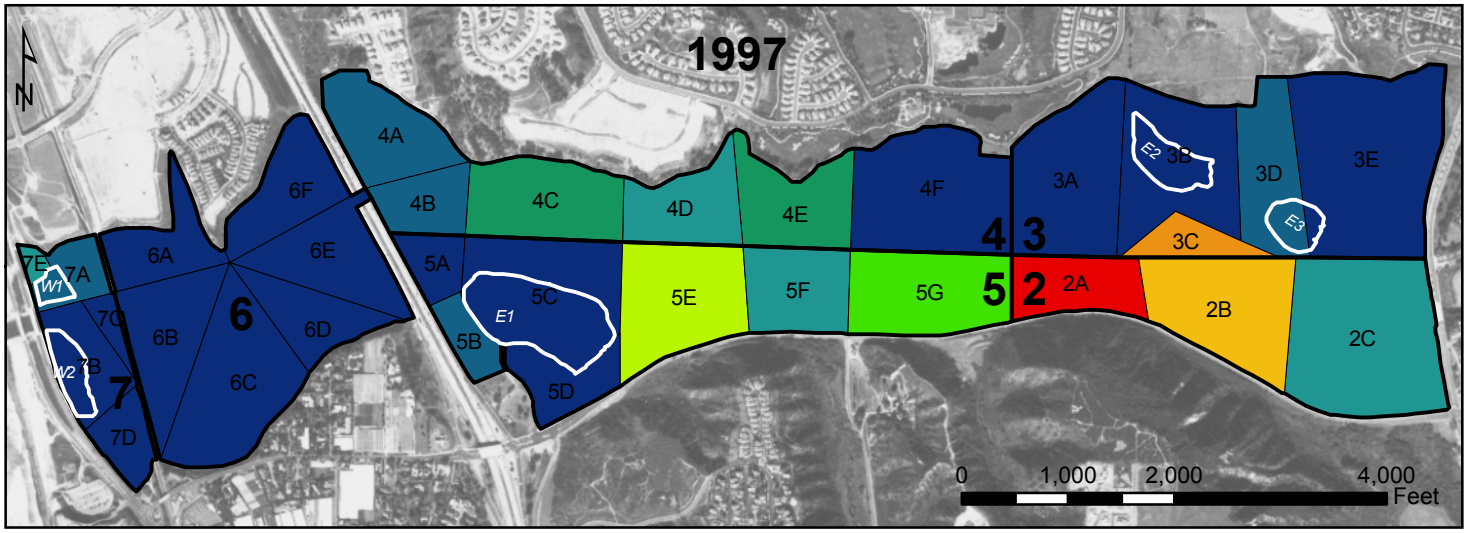


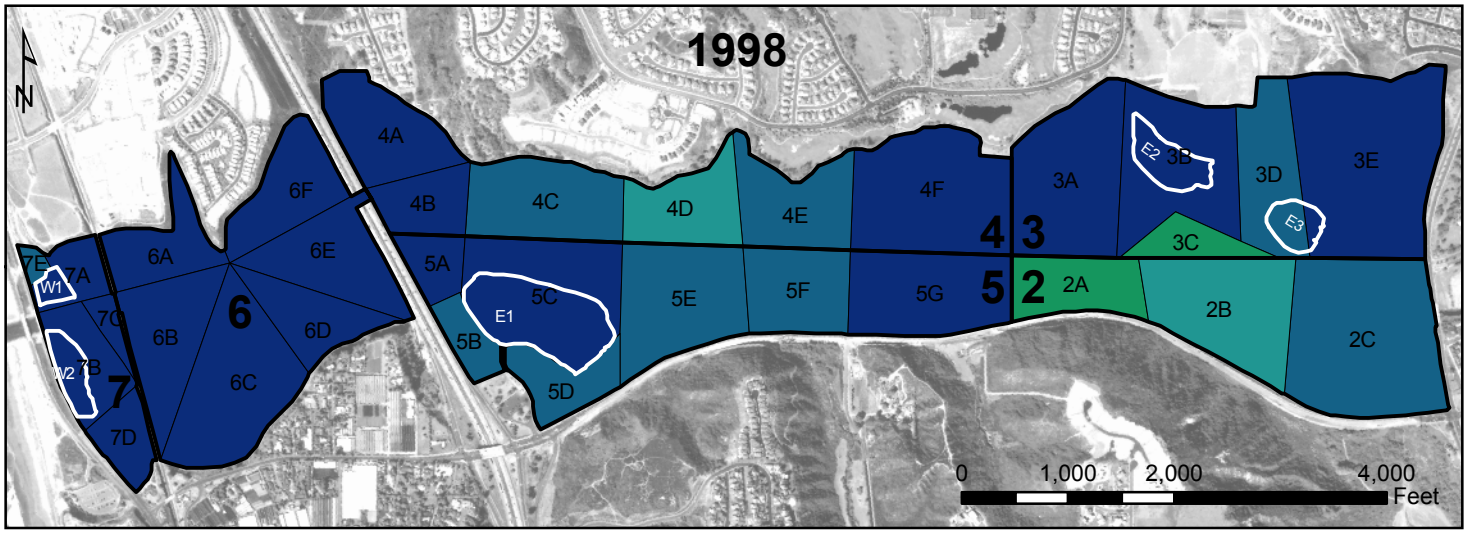


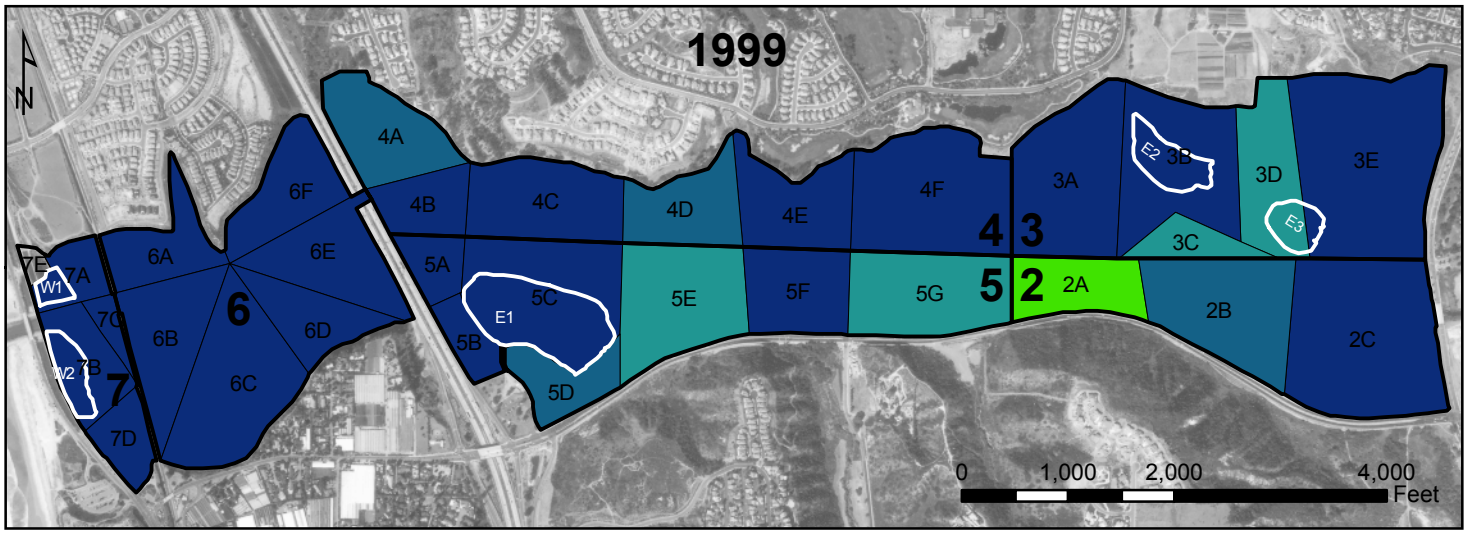
Small and large shorebird density (birds/acre) by subzone by year

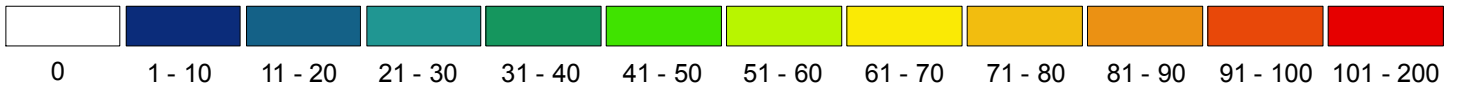
Figure 6-8b

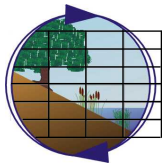
This Page Intentionally Left Blank









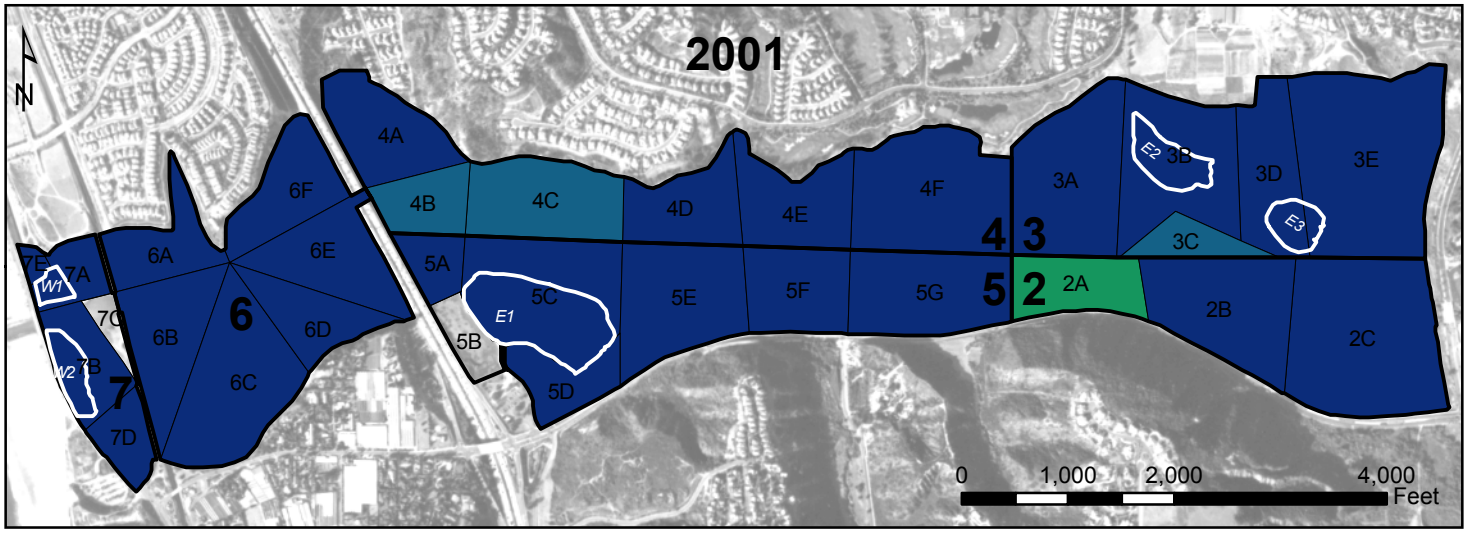


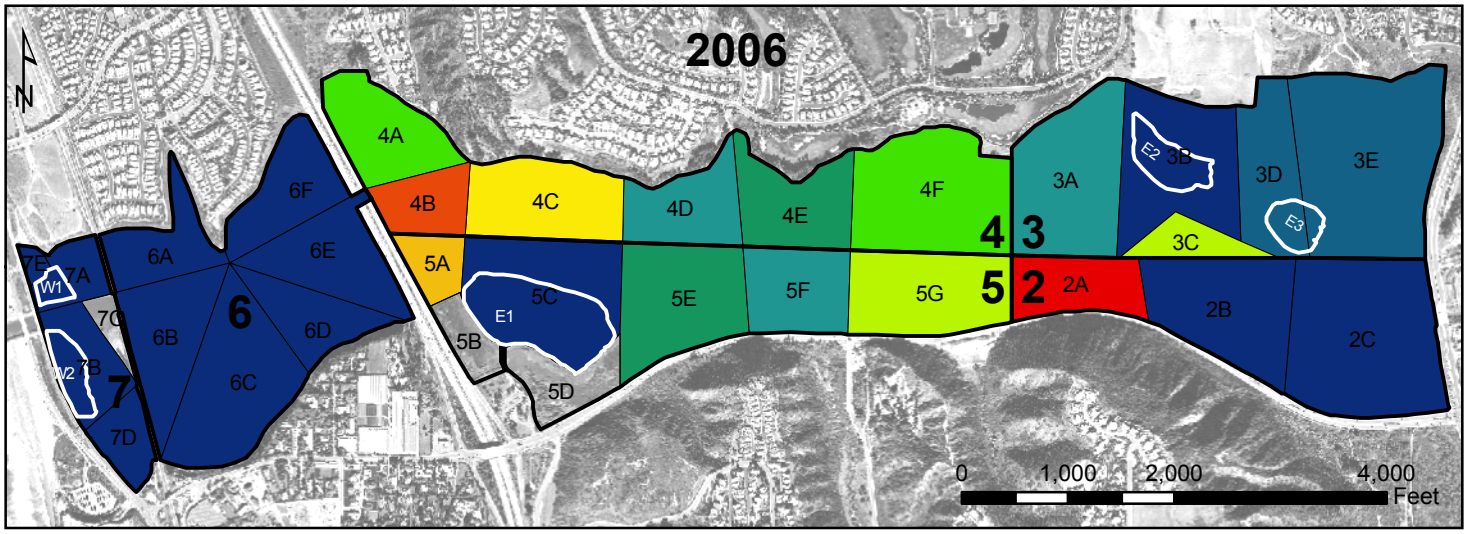
Waterfowl density (birds/acre) by subzone by year

Figure 6-9a

Merkel & Associates, Inc.

This Page Intentionally Left Blank





Waterfowl density (birds/acre) by subzone by year

Figure 6-9b

Merkel & Associates, Inc.

This Page Intentionally Left Blank

dabbling ducks and American coots in the fall and winter surveys from 1997 to 2006. These waterfowl foraged heavily in the shallow waters near shore and in the several small channels delivering freshwater input from nearby creeks and storm drains. Species such as gadwall, green-winged teal, American wigeon, and American coot consistently loafed in large numbers in this area in the winter months. Most other subzones were used in consistently lower numbers until the 2006 survey year, when waterfowl were distributed more widely throughout the east basin, represented primarily by American coot and high numbers of American wigeon.

Usage of the lagoon by subzone by all birds (all guilds combined) each survey year is presented in Figure 6-10, which better accounts for the uneven distribution of habitats within each subzone. Although the influence of waterfowl and shorebird usage is clearly evident, the figures show usage of the west and central basins, as well as the far eastern end of the lagoon, by birds in other guilds, which were primarily gulls, terns, and upland species. Avian usage varied between years, with usage being highest in the east basin at the end of the 10-year monitoring period. The high density in the central basin in 2006 is accounted for by the presence of 492 elegant terns on the flood shoal in April.

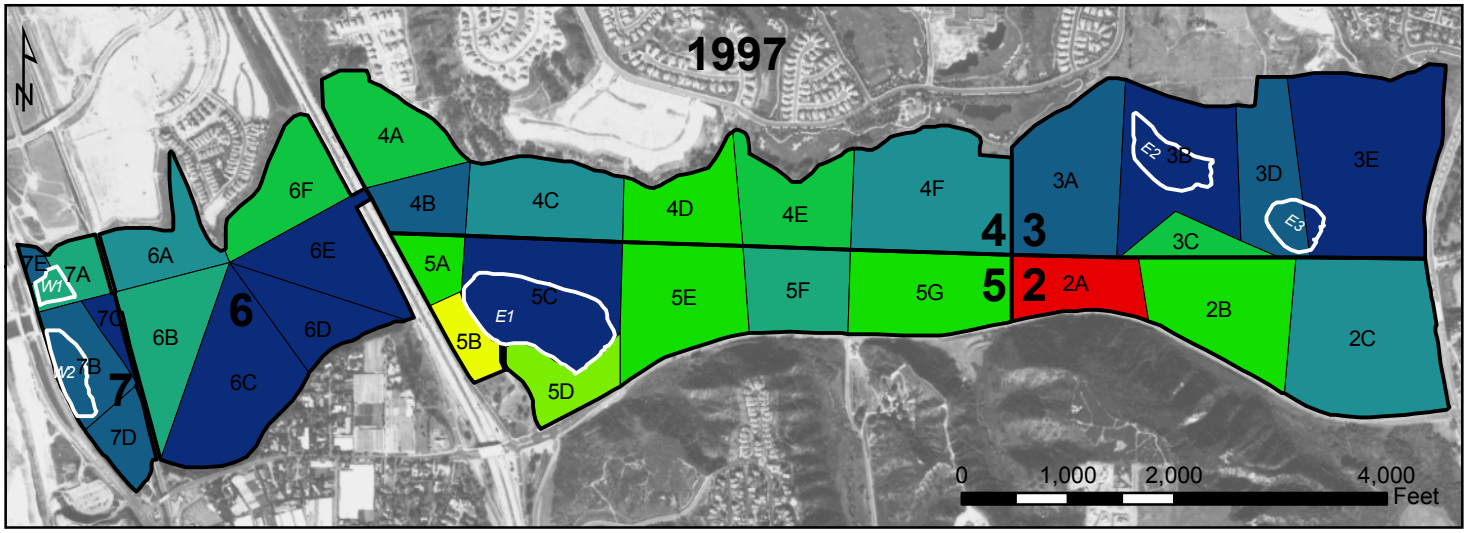
Figure 6-11 presents avian density by subzone for all birds during all surveys combined. In general, the most highly used subzones were those that include diverse habitats, including shallow water and exposed mudflat. The zones of the central basin that included some of the deeper areas of the lagoon were used by the least number of birds, but featured some mudflat and salt marsh shoreline that was used regularly.

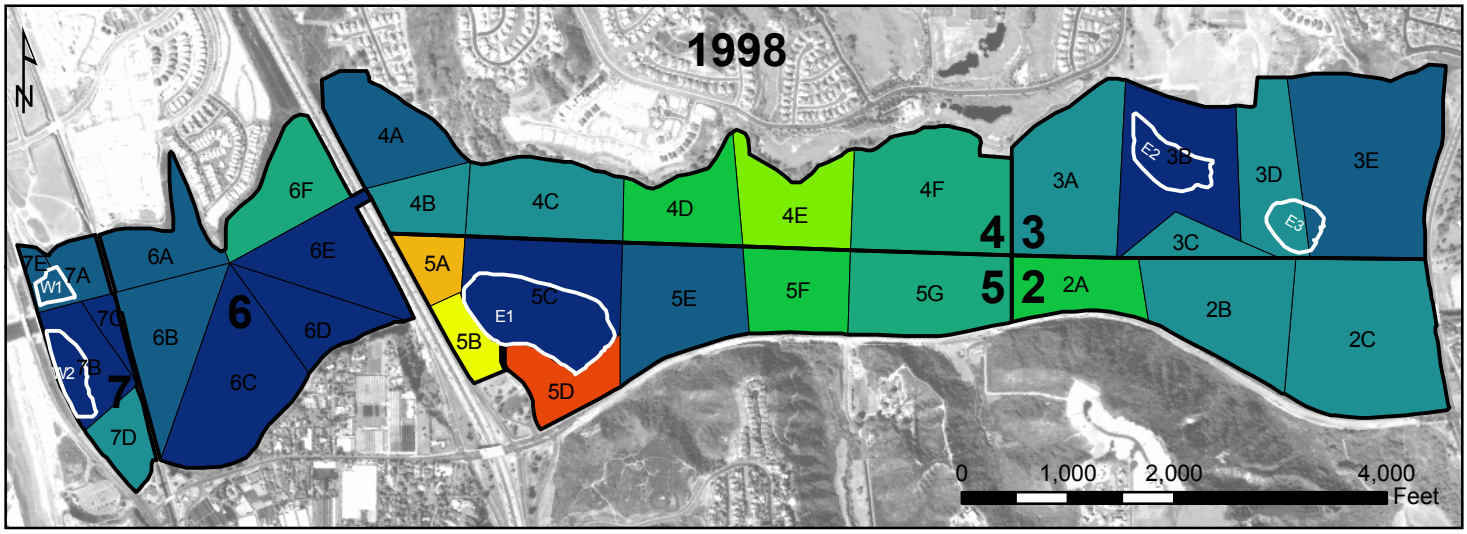
6.2.5 Avian Habitat Usage

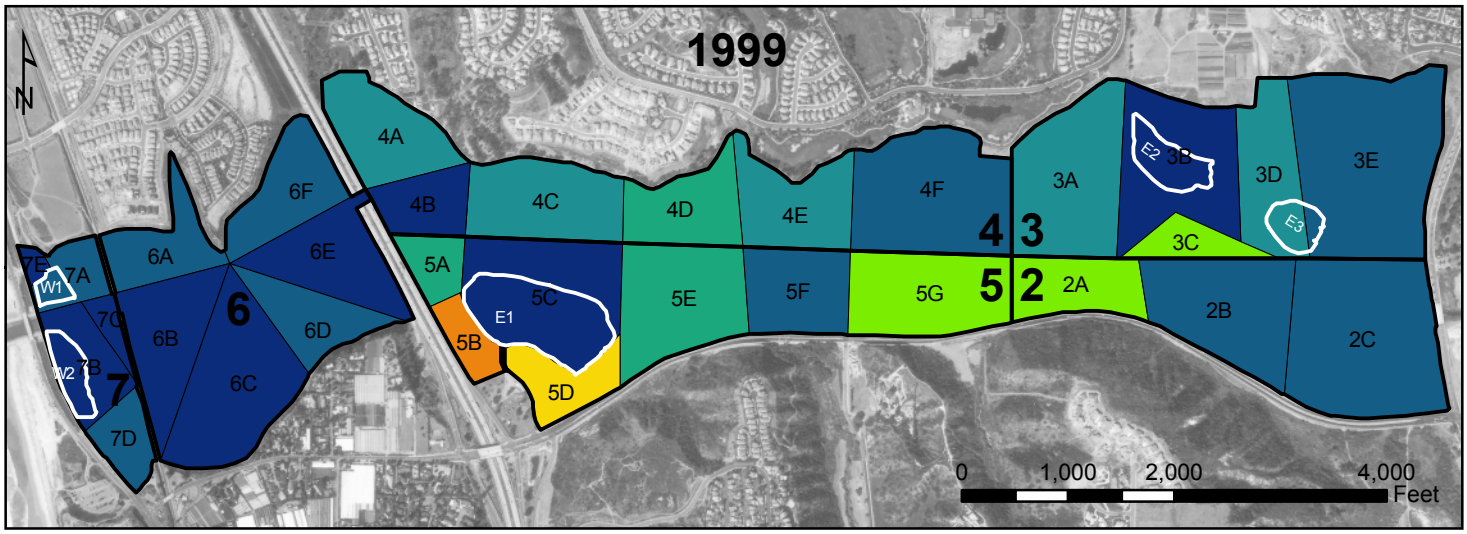
All non-flying birds recorded were assigned a code indicating the habitat that they were occupying at the time of observation. The results are presented in Figure 6-12. The habitats consistently occupied by the highest numbers of birds were mudflat, shallow water, and open water, as would be expected since shorebirds and waterfowl were the most abundant birds and prefer these habitats.

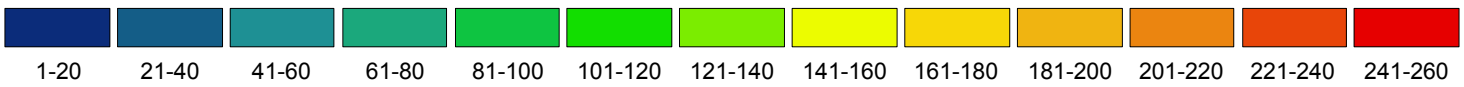
The number or diversity of birds using a particular habitat, however, is just one measure of the value of that habitat. The southern coastal salt marsh (including pickleweed and cordgrass dominated areas), which was the second most abundant habitat by the end of the monitoring program in 2006 (over 26% of total), was only used by 1.5% of the birds observed, but provided the specialized breeding habitat for the state endangered Belding's Savannah sparrow and the state and federally endangered light-footed clapper rail. Both species increased in abundance over the length of the post-restoration monitoring period, due in large part to the expansion of this habitat within the lagoon.

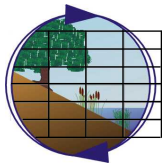
This Page Intentionally Left Blank









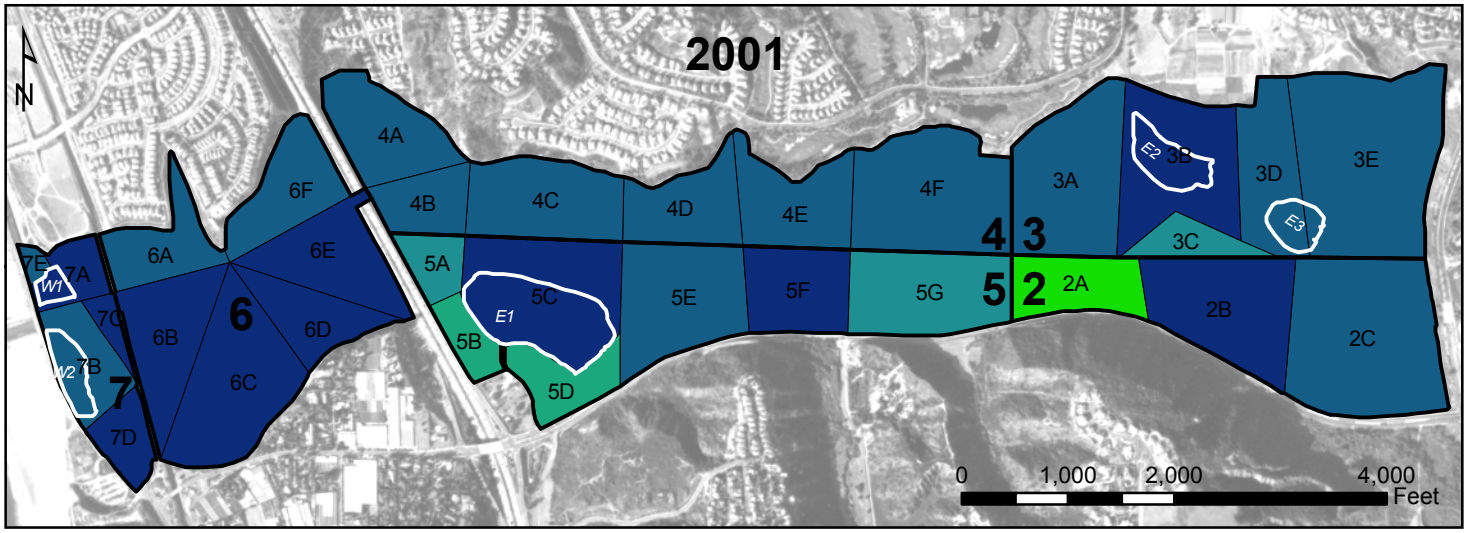


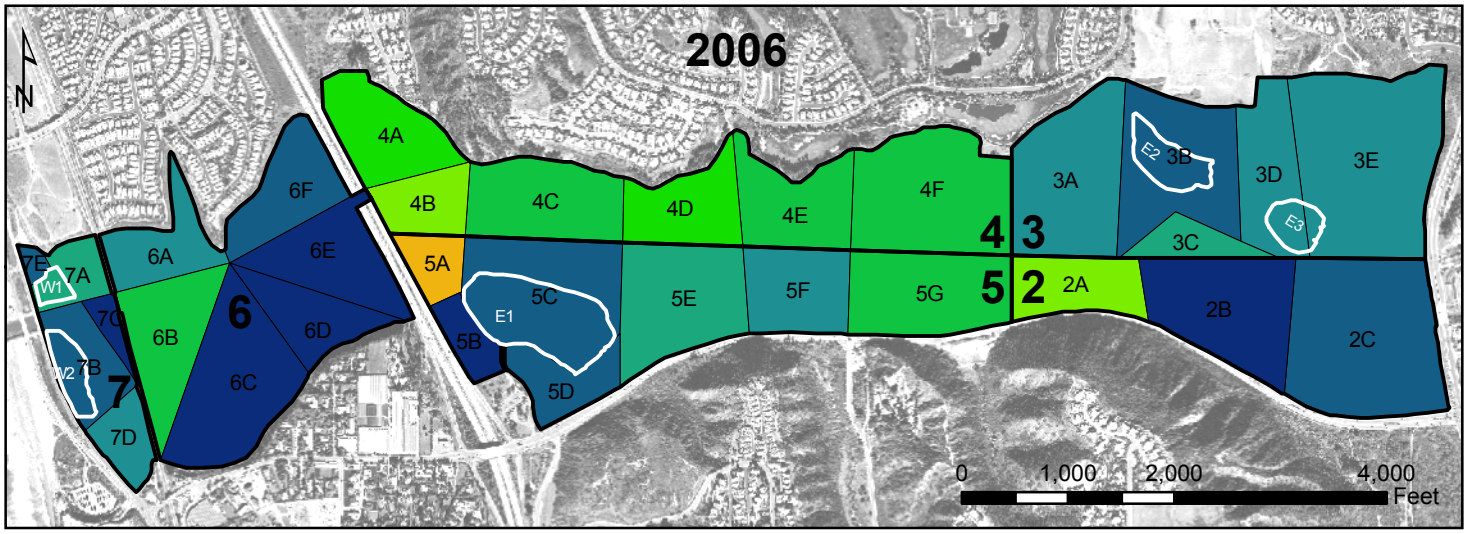
Total avian density (birds/acre) by subzone by year (all guilds combined)

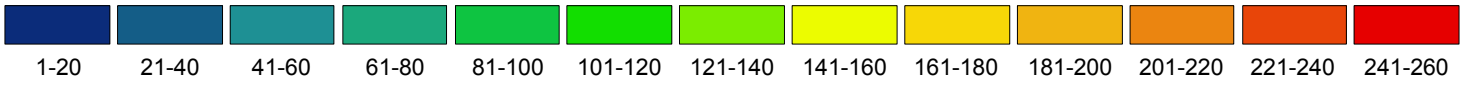
Figure 6-10a

Merkel & Associates, Inc.

This Page Intentionally Left Blank





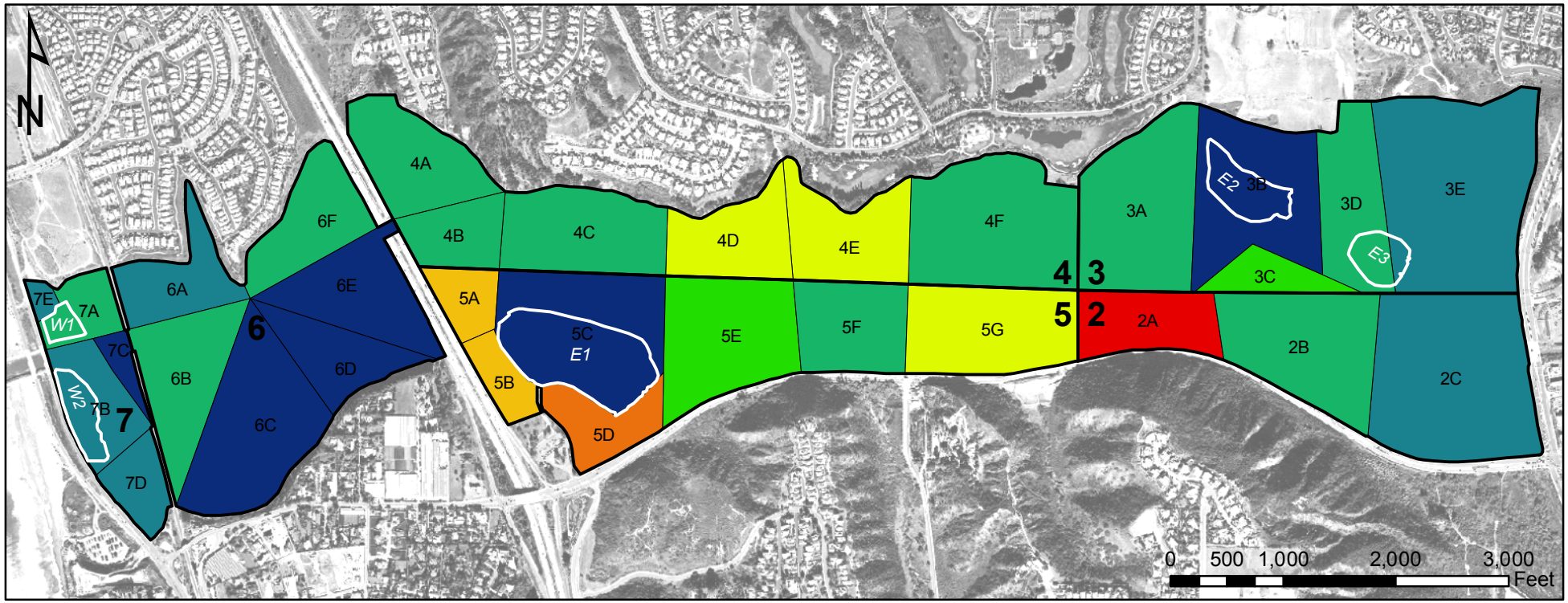


Total avian density (birds/acre) by subzone by year (all guilds combined)

Figure 6-10b

Merkel & Associates, Inc.

This Page Intentionally Left Blank



Total density (birds/acre) of all avian guilds for years 1997, 1998, 1999, 2001, & 2006 combined

Figure 6-11

Merkel & Associates, Inc.

This Page Intentionally Left Blank

More limited areas of upland, willow/riparian, freshwater marsh, and brackish marsh were used by fewer numbers of birds, but increased the diversity of the avian community at Batiquitos Lagoon considerably, providing habitat for other migratory birds, upland species, and species preferring transitional freshwater/brackish conditions.

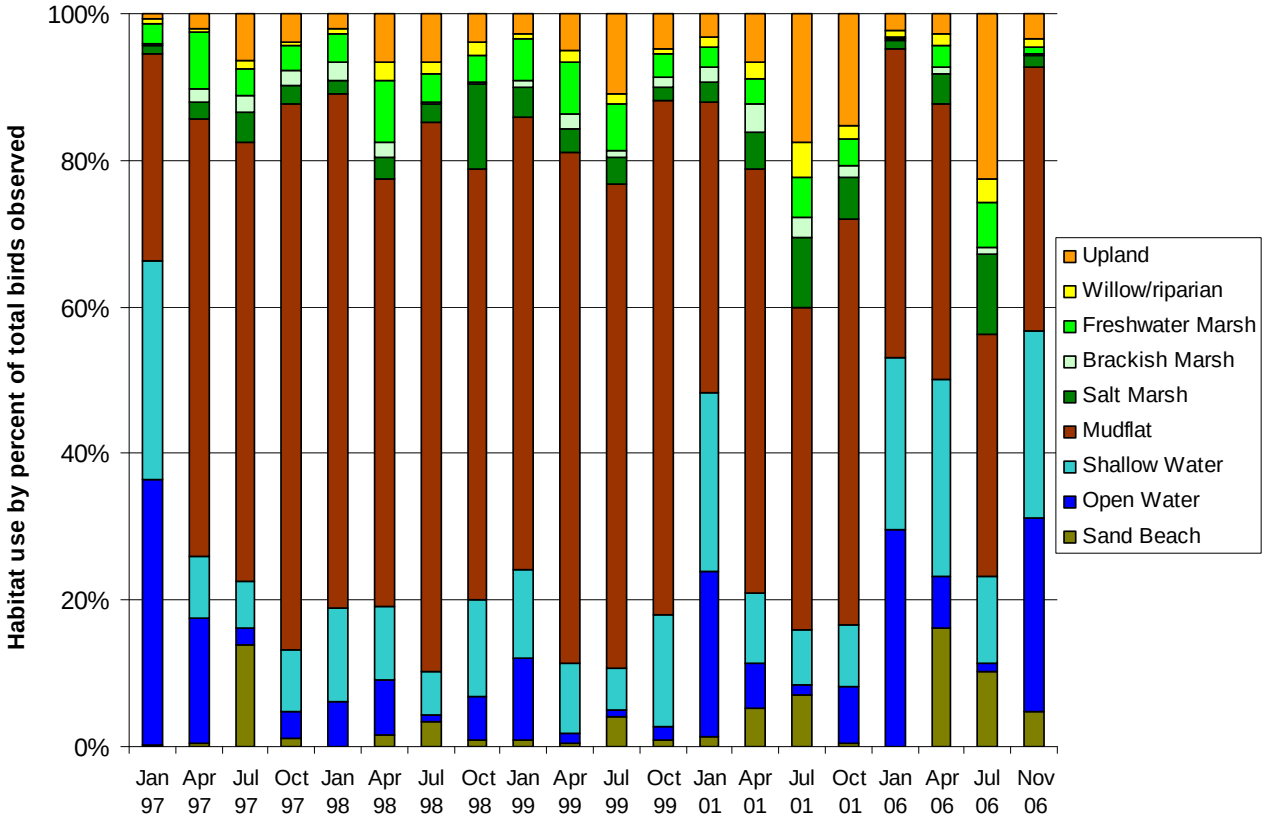


Figure 6-12. Post-restoration habitat use by percent of total birds observed.

6.2.6 Regional Significance of Batiquitos Lagoon

The number of avian species observed within Batiquitos Lagoon during the post-restoration monitoring program is plotted in comparison to data collected in other coastal open bays and estuaries of southern California in Figure 6-13. These data were generally collected many years ago under different conditions than presently exist, and sampling intensity and extent varied substantially among these areas. For this reason, the results should be viewed as a general means of assessing the relative performance of Batiquitos Lagoon. The data were compiled from the following sources: San Elijo Lagoon (King et al. 1987, MEC 1993b), San Diego Bay (Tierra Data 2008), Mission Bay (City of San Diego 1989, Unitt 2004), San Dieguito Lagoon (Audubon 1990, MEC 1993a), Los Peñasquitos Lagoon (CDFG 1974), and Agua Hedionda Lagoon (CDFG 1976, MEC 1995). The number of species at Batiquitos Lagoon during 1997 (127), 1998 (133), 1999 (131), 2001 (119), and 2006 (130) was consistent year to year and fell within the range recorded at other southern California sites.

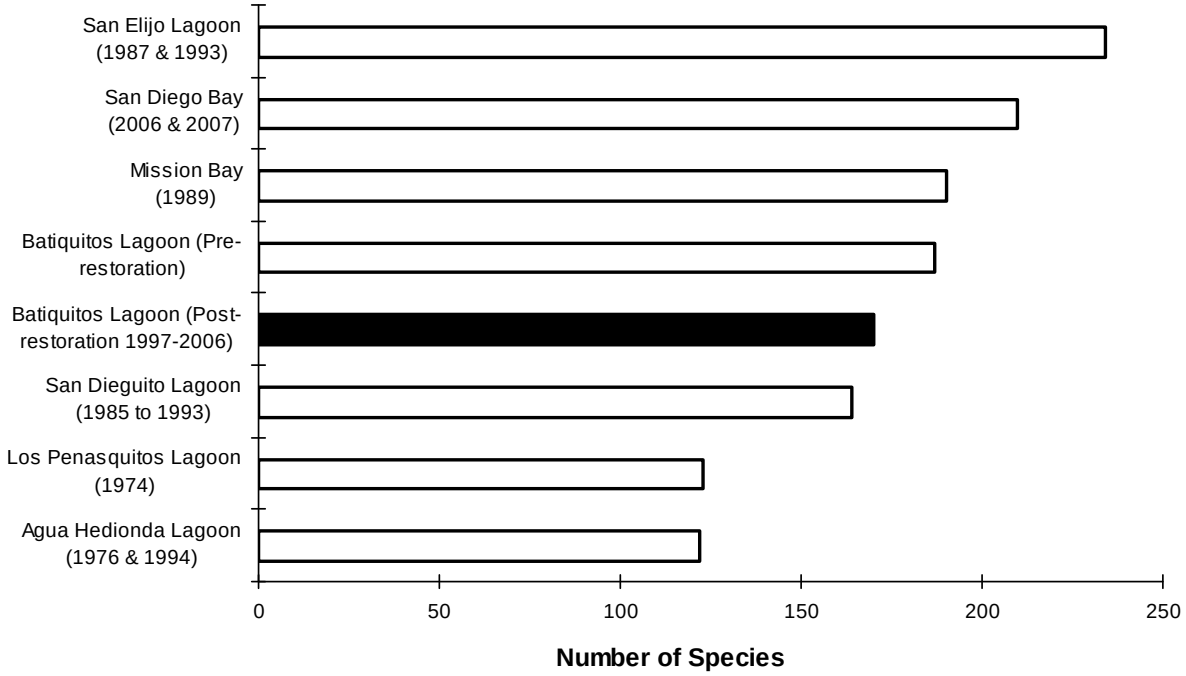


Figure 6-13. Comparison of numbers of bird species within southern California bays and estuaries.

San Elijo Lagoon was recorded to support the highest number of bird species over the course of a 10-year study (King et al. 1987), including a high percentage of upland birds, as well as a number of rocky intertidal species that would not have been recorded at Batiquitos Lagoon. A list of avian species historically observed in coastal bays and estuaries of southern California is presented in Appendix 6-7. This table, adapted from MEC (1993a), represents a cumulative list of species that has primarily been compiled from multiple surveys conducted over several monitoring years. Review of this table reveals that nearly all species that would be expected to occur within a fully tidal lagoon were documented to occur at Batiquitos Lagoon following the restoration. Estuarine and lagoon species seen at other lagoons but not at Batiquitos were generally rare or occasional species, such as Baird's sandpiper (*Calidris bairdii*), snow goose, and yellow-crowned night heron (*Nyctanassa violacea*) (San Elijo Lagoon).

6.3 DISCUSSION

The primary change in the avian community over the 10-year post-restoration period was the lagoon's conversion from its condition pre-restoration, which was primarily a freshwater and brackish marsh, to its post-restoration condition: a coastal salt marsh with diverse habitats including pickleweed and cordgrass dominated salt marsh, brackish marsh, freshwater marsh, open water, shallow water, and mudflats (see Chapter 3). The variability in pre-restoration avian survey results reflects the highly unstable conditions at Batiquitos Lagoon in the 1980's and 1990's. These included intermittent inundation, alternately elevated and reduced salinities, fluctuating water temperatures, and the resulting inconsistency in the extent of exposed mudflats and food supply for birds. The lagoon was generally very dry in late summer and fall, with large expanses of open freshwater available for migratory waterfowl in the wintertime, though most

available mudflat was inundated. Post-restoration, conditions at the lagoon were more stable and reliable for avian species. Both open water and mudflat habitat were available year-round, a condition that was reflected in the post-restoration abundance of migratory species.

Avian diversity increased post-restoration, even with the increased upland species counted outside the restoration boundary in the pre-restoration counts. This increased diversity is reflective of the increased habitat quality, diversity, and stability that developed over the 10-year monitoring program. Continued observations of species such as the federally listed light-footed clapper rail, California least tern, and western snowy plover, the state endangered Belding's Savannah sparrow and peregrine falcon, and nesting black skimmer, a Species of Special Concern, have not only added to the species diversity of the lagoon, but indicate the contribution of the lagoon to the recovery of these species. The overall abundance of individual birds remained high but variable post-restoration, with fall and winter months having the highest counts.

The changes in diversity and abundance of key avian groups in response to the lagoon restoration are discussed individually below.

6.3.1 Post-restoration Avian Community Development

The composition of the waterfowl at Batiquitos Lagoon changed in diversity and distribution after the restoration. In winter months, dabbling ducks were the most abundant bird group during pre-restoration surveys and included northern shoveler, gadwall, mallard, northern pintail, and cinnamon teal, and were generally found feeding and resting in shallow water and along the shoreline. These species typically forage in shallow water and prefer fresh or brackish water, although many do occur in coastal saltwater lagoons (Unitt 2004). Mallard and northern shoveler were still abundant in the first post-restoration survey (one month after the lagoon was opened to the ocean), but their low numbers in the following years may reflect their relocation to freshwater habitats. Northern pintail continued to be seasonally abundant, and green-winged teal and American wigeon became the dominant dabbling species, though the species listed above were still present in lower numbers. American coot were abundant both prior to and following the restoration. The persistence of small freshwater inputs around the lagoon continued to attract dabblers associated with freshwater habitats. These areas were generally the focal points of waterfowl loafing and foraging, and supported the highest densities of ducks (Figure 6-9).

Ruddy duck and redhead were the most abundant diving ducks pre-restoration. As with dabbling ducks, it appeared to take a full season for the ruddy ducks and redheads to relocate to preferred freshwater environments. The 20-year high in diving ducks that occurred in January 1997 (one month post-opening) was attributable to unusually high numbers of redhead and ruddy duck. The ruddy duck prefers brackish lagoons and freshwater lakes, though it was still present during the winter months of the following years. Redhead, although diving ducks, seem to prefer shallower water (Unitt 2004) and may have relocated to shallower, freshwater sites. Because the restoration provided more deepwater habitat than was available pre-restoration, other diving ducks became more numerous post-restoration. The highest number of scaup observed pre-restoration was 53 (November 1989) compared with 201 post-restoration (January 2006). The most canvasback observed pre-restoration was 9 (July 1995), compared with 114 post-restoration

(January 2001). Loon species, which prefer deepwater habitat, were regularly observed post-restoration, while only one loon was recorded pre-restoration. Finally, although surf scoters are much more common offshore or in deep bays rather than in estuaries or lagoon, the highest number during pre-restoration surveys was 9 (May 1987), while 68 were observed during one post-restoration survey (April 1998).

The different, yet continued diversity of waterfowl species post-restoration, including diving and dabbling ducks, grebes, loons, and cormorants, is the result of the varied habitats continually available (both shallow and deep water, year-round mudflat, and marsh ranging from salt to freshwater) and the availability of forage plants and animals (Chapters 4, 5, and 8).

Prior to restoration, the seasonal inundation of the lagoon sometimes limited its availability to migrating shorebirds. Thousands of shorebirds would stop at the lagoon on their southward migration in late summer and fall when the lagoon was at its driest and extensive areas of mudflat and shallow water were available for feeding and resting. However, on the spring return northward, the water in the lagoon was too high in many years, and small shorebirds would bypass the lagoon (City of Carlsbad and U.S. Army Corps of Engineers 1990). Only in years when the lagoon remained dry or had drained by spring were migrant shorebirds observed stopping in any great numbers during this season.

The restoration created adequate mudflat and tidal regularity to provide a reliable year-round stopping point for migrating shorebirds. The number of shorebirds increased in the first three years after the restoration, remained higher than in most pre-restoration surveys, and were present in all seasons. This suggests that Batiquitos Lagoon is now a resource for migrating shorebirds heading both north and south, as well as for over-wintering by some. Given the tendency of some migrating shorebirds to only stop at a resting point for a short period (as few as 1-3 days for western sandpipers), the timing of the survey could either capture or miss large migratory events among small shorebirds, so “trends” in shorebird numbers year to year in this dataset should be looked at with caution.

Between surveys in 2001 and 2006, there was a considerable expansion of cordgrass habitat onto areas of mudflat. It was anticipated that this expansion could result in a reduction in foraging habitat for shorebirds. However, the high small shorebird numbers in 2006 suggested that even with the maturation of the marsh habitats, there was still adequate mudflat to attract shorebirds. There was a notable increase in semi-palmated and black-bellied plovers post-restoration, suggesting increased and adequate epibenthic food resources for gleaning species.

There is concern about the continued progression of tidal muting, where the mudflat may become inundated for increasingly longer periods, although there was no evidence that in its present state shorebird usage was compromised by unavailability of mudflat habitat (see Appendix 6-6). Implementation of an adequate maintenance dredging program will ensure the continued availability of mudflat.

Large shorebirds such as the willet, marbled godwit, whimbrel, and long-billed curlew increased in numbers after the restoration, suggesting increased and adequate infaunal food resources. A

decline in black-necked stilt and American avocet post-restoration is likely due to habitat changes affecting their nesting areas, with previously dry salt panne receiving tidal influence after the restoration. Both species nested at E-3 initially post-restoration; however, no nesting by these species occurred there during the last few years of the monitoring program, perhaps due to the extensive vegetation that had developed on the island.

There was little change in wading marshbird abundance post-restoration. For herons, abundant prey was available pre-restoration in the form of non-native fish trapped in restricted ponds. Post-restoration, this resource was replaced with marine shallow water habitat populated by gobies (Family Gobiidae) or dense aggregations of juvenile schooling fish such as topsmelt (*Atherinops affinis*). The post-restoration establishment of a rookery by several heron species in the eucalyptus grove on the north shore is a benefit to this group of birds, which has limited areas with both appropriate nesting habitat, protection from predators, and an adequate food source. Rails in the wading marshbird guild are more secretive and were generally only counted when they were inadvertently flushed. Sora continued to be regularly present in the freshwater, brackish, and salt marsh post-restoration. Light-footed clapper rails were more closely monitored during the annual statewide breeding census (conducted by D. Zembal) and increased in number over time as cordgrass habitat expanded (see Chapter 7).

Eight to ten species of raptors were observed at the lagoon during nearly every post-restoration survey. Fewer raptors were observed pre-restoration, and no peregrine falcon, osprey, merlin, or turkey vulture were recorded in the MBA, MEC, and WRA pre-restoration surveys. The lagoon, post-restoration, provides a greater diversity of raptor foraging habitats and prey than pre-restoration.

All aerial fish forager species were present in higher numbers post-restoration, with the exception of Forster's terns. This increase is probably related to increased year-round open water foraging and an increased quality and abundance of prey. The increase in prey is a direct result of the lagoon being opened to marine influence. In addition, the numbers of nesting least terns post-restoration were much greater than pre-restoration due to the creation of the nesting sites (see Chapter 7). The decline in Forster's terns is related to their abandonment after 1997 of their nesting site in the salt marsh on the west shore of the central basin. This is suspected to be related to the heavy recreational use of the site by fishermen. The marsh and shoreline where they nested was regularly littered with fishing line and trash and anglers were seen fishing from this point on many occasions during the first few years post-restoration. A limited number of pairs of Forster's Terns were observed nesting again at the site in 2006.

Several species of upland birds were more abundant post-restoration than pre-restoration (Appendix A6-6), including the Belding's Savannah sparrow. This species is discussed in detail in Chapter 7. The California gnatcatcher was consistently observed in the coastal sage scrub along the lagoon boundary.

The overall persistence and improvement of a highly diverse and abundant avian community post-restoration is due to the balanced diversity of habitats, the stabilization of environmental conditions, and the increased availability of food resources. The increased and perennial

availability of habitats was well documented in Chapter 3. Despite the conversion of large expanses of pre-restoration mudflat to open water and salt marsh habitats, the resulting suite of habitats post-restoration continued to support shorebirds, waterfowl, and other species. The stabilization of environmental conditions was documented in the physical monitoring of water quality and tidal condition, with daily tidal flushing and a muting of the water quality extremes seen pre-restoration (see Chapters 2 and 5). Pre-restoration, the lagoon was a generally freshwater system with invertebrate fauna primarily limited to insects, with highly seasonal micro and macroalgae and fish available as forage. The City of Carlsbad/U.S. Army Corps of Engineers EIR/EIS (1990) noted that during July and August, the large expanses of dried "floral mats" were nearly uninhabited by shorebirds. In contrast, post-restoration tidal conditions brought in a year-round supply of fish for piscivorous birds, mudflats populated by a diverse community of benthic infauna and epifauna for probing and gleaning species, and year-round eelgrass and micro and macroalgae for waterfowl. Chapter 8 reports the development of a benthic infaunal community of polychaetes, bivalves, and crustaceans, all important prey items for shorebirds and wading marshbirds.

6.3.2 Regional Significance of Batiquitos Lagoon

Coastal wetlands have declined in size and quality over the last 150 years due to development, landfills, diking, dredging, reduction of freshwater inflow, and other human disturbances. This decline has had a major effect on migrating and over-wintering birds such as waterfowl and shorebirds, and has had a devastating effect on breeding birds such as light-footed clapper rail, Belding's Savannah sparrow, western snowy plover, and California least tern. These species have specialized breeding and foraging requirements found only in coastal wetlands.

Batiquitos Lagoon is located along the Pacific Flyway, one of the four principal migratory routes in North America, and is utilized by thousands of birds for food and refuge during fall and spring migration. There are a number of wetlands within the vicinity of Batiquitos Lagoon. The value and function of each of these wetlands for nesting, migrating, and wintering birds varies and is a function of the habitat types and food sources available. The major wetlands include San Elijo Lagoon, San Dieguito Lagoon, Los Peñasquitos Lagoon, Mission Bay, San Diego Bay, and Agua Hedionda Lagoon.

Most of these lagoons have some similarities to the restored Batiquitos Lagoon, although not all are fully tidal and influenced by major or seasonal freshwater sources. Los Peñasquitos Lagoon has the most similarities and maintains similar habitat diversity that supports a high number of wetland avian species. Habitats include salt marsh, tidal mudflats, shallow open water, deep open water channels, beaches, and freshwater marsh. San Dieguito Lagoon is also fully tidal but has a limited inflow of freshwater. San Elijo Lagoon is a frequently closed system that is predominantly fresh to brackish water. San Diego Bay, Mission Bay, and Agua Hedionda are large open saltwater systems with some areas of open mudflats and beaches. These large bodies of water are heavily used for recreation but are still valuable to a large number of avian species.

More avian species were recorded at Batiquitos Lagoon post-restoration than at Los Peñasquitos Lagoon, San Dieguito Lagoon, and Agua Hedionda Lagoon, likely because Batiquitos supports a higher diversity of habitats than the three other coastal salt marshes. More species were recorded

at San Diego Bay and Mission Bay than Batiquitos Lagoon; however, this is expected since these are much larger systems. San Elijo is comparable to Batiquitos Lagoon with coastal salt marsh the dominant habitat and freshwater and riparian habitats at the margins and upper reaches. The increased number of avian species reported at San Elijo is due in part to observations of rare species as well as upland species not recorded at Batiquitos Lagoon within the restoration area. Examination of the wetland species at both site finds them to be similar in both diversity and variability year to year.

The high avian diversity and usage of Batiquitos Lagoon reflects the improved mix of habitat types created by the restoration project and the significant forage and shelter resource it provides to both resident species and birds migrating along the Pacific Flyway.

6.4 RECOMMENDATIONS

- Expand signage around the lagoon indicating sensitive areas and listing prohibited activities (such as kayaking and fishing). Access limitations cannot be enforced until the signs are in place. Enforcement of signage is mandatory as people and unleashed dogs are regularly observed in the wetland and illegal trails have been cut through coastal salt marsh throughout the lagoon.

- Conduct maintenance dredging to maintain the inlet, reduce tidal muting, and maintain adequate exposure of mudflats and intertidal vegetation.

- Conduct annual surveys, particularly in the winter months, when waterfowl and shorebirds are abundant, to provide lagoon managers the data required to assess changes within the lagoon. Surveys should be completed for the entire lagoon, using the methodology employed in the pre- and post-restoration monitoring program to allow for comparison of results.

6.5 LITERATURE CITED

Audubon Society. 1990. Compilation of Bird Species Observed at San Dieguito Lagoon, 1985-1990. Unpublished.

Baumgartel, M. 2006. Batiquitos Lagoon Foundation Monthly Bird Survey Raw Data, collected by Mona Baumgartel for the Batiquitos Lagoon Foundation, 1993 to 2003. Unpublished.

California Department of Fish and Game (CDFG). 1976. The Natural Resources of Agua Hedionda Lagoon. Coastal Wetland Series 16. 110 pp.

California Department of Fish and Game (CDFG). 1974. The Natural Resources of Los Peñasquitos Lagoon and Recommendations for Use and Development. Coastal Wetland Series 7. 75 pp.

City of Carlsbad and U.S. Army Corps of Engineers. 1990. Batiquitos Lagoon Enhancement Project Final EIR/EIS, Carlsbad, CA, Volumes 1-3.

City of San Diego. 1989. Mission Bay Park Bird Survey, 1989.

King, D.G., Jr., M. Baumgartel, J. DeBeer, and T. Meyer. 1987. The birds of San Elijo Lagoon, San Diego County, California. Western Birds 18:177-208.

MEC Analytical Systems, Inc. 1995. 1994 and 1995 Field Survey Report of the Ecological Resources of Agua Hedionda Lagoon. Prepared for San Diego Gas and Electric Company. 36 pp.

MEC Analytical Systems, Inc. 1993a. San Dieguito Lagoon Restoration Project Biological Baseline Study, March 1992 - May 1993. Draft technical memorandum submitted to Southern California Edison. Sections 1-6.

MEC Analytical Systems, Inc. 1993b. Final Report on Avian Surveys Conducted in Association with the Proposed San Elijo Outfall Improvement Project: Savannah Sparrow Surveys, Ocean and Beach Surveys. Prepared for Helix Environmental Planning, Inc., La Mesa, CA.

MEC Analytical Systems, Inc. 1990. The Birds of Batiquitos Lagoon, 1989. Prepared for City of Carlsbad. pp. 1-6.

Michael Brandman Associates (MBA). 1988. Technical Memorandum: The Avifauna of Batiquitos Lagoon, San Diego County, California: A Baseline Assessment (Task 6). Prepared for CH2M Hill. pp. 1-32.

Tierra Data. 2008. Draft San Diego Bay Avian Species Survey Report. May 2008.

Unitt, P. 2004. San Diego County Bird Atlas. Proceedings of the San Diego Society of Natural History. 645 pp.

Wetlands Research Associates (WRA). 1995. Batiquitos Lagoon Avian Diversity Survey Summary. Prepared for the Port of Los Angeles.